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ENGINES OF THE STEAMER LA NORMANDIE.

THE motive apparatus of the Générale Transatlantique Compagnie's steamer La Normandie presents, properly speaking, no new arrangements, but an effort has been made to combine in its construction all that could contribute to make it a non-cumbersome engine that should be easy to maneuver and keep in repair, that should exert but little strain on the ship, and, finally, that should prove economical as regards consumption of fuel.

We shall succinctly describe the boilers and the engine, properly so called, and afterward make known the results of the first trials.

The boilers are of the tubular variety, with cylindrical shells, such as are at present in general use on ships. They have 72 meters of grate surface, 1,900 meters of heating surface, and are run at a pressure of 6 kilos. They have in all, 36 furnaces of a diameter of 1·07 m., and have furnished more than 6,500 indicated H. P. during a trial of six hours, and 6,900 H. P. during an entire trip, with a natural draught.

The steamers Labrador and Canada, which were put in service in 1875 and 1876, and the boilers of which are only 3·25 m. in diameter, with 24 furnaces of 40 meters grate surface and 948 meters of heating surface, and a valve load of 4·25 k., have given but 3,250 H. P. during an entire trip. Such a performance, compared with the grate and heating surfaces, is inferior to that of La Normandie, and such inferiority, which is doubtless due partly to the less pressure and partly to the engine, is perhaps attributable in part also to the use of furnaces of smaller diameter.

These latter do not appear to utilize the fuel so well as larger ones do, at least within the usual limits. This fact explains itself. The section of the ash-pans varies about as the square of the diameter of the furnace; and the entrance of the air, with an equal grate surface, is effected, then, under better conditions in the large furnace. On another hand, the distance from the grate to the top of the furnace is also greater in the large furnace, and the result of this is that there is more free space above the fuel and that the combustion of the gases proceeds better.

But what specially gives the boilers of La Normandie their advantage is their great diameter, the effect of this being to diminish the space that they occupy in the hold. Upon a ship, all the space included between the plane on which the boilers rest and the deck-beams above is lost for freight and passengers. It is fitting, then, to give it up entirely to the boilers, and to economize in the horizontal part as an offset. This consideration should lead to the adoption of shells of as large diameters as the height beneath beams will permit of, and, as a consequence, to the adoption likewise of furnaces of large diameter. A few figures will serve to show how much economy in space may thus be realized.

Upon La Normandie, where the diameter of the shells is 4·2 m., the boilers, with their heating chambers, occupy a horizontal superficies of 270 meters and a space of 1,242 cubic meters. Upon Le Labrador, the boilers, which have but two furnaces 3·25 m. in diameter, occupy a horizontal superficies of 203 meters and a space of 938 cubic meters.

The space occupied by a 100 indicated horse power is 18 meters on La Normandie and 29 on Le Labrador.

The boilers of La Normandie are divided into three groups of twelve furnaces each, and the central group is cut in two by a water-tight compartment, so that the evaporating apparatus occupies two compartments, and that in case one of the latter should be flooded through a leak the engines could be still run with half of the boilers.

There are three furnaces to each boiler front. The shells of the extreme group are double, that is to say, they have three furnaces at each extremity, and their length is 5·6 m. The boilers of the central group are simple, and are but 2·9 m. in length.

When the Compagnie Transatlantique ordered La Normandie, there was a sort of antipathy in England, at least among certain builders, against the use of steel for the construction of boilers, and the builders of La Normandie not daring to have recourse to that metal, her boilers were made of iron. But the company's engineers affirm that if it should become a question of ordering new ones, they would adopt steel. Eighty per cent. of the marine boilers that are now being constructed in England are made of this metal; and it appears to be well demonstrated that when soft steel is employed and care is taken to anneal the pieces that have been shaped, safety is secured against accident.

The boiler accessories do not differ from those found at the present day upon the majority of marine high-pressure apparatus. We shall cite merely (1) the feed cocks with clack valves, so arranged that the latter may be inspected or replaced without interfering with the operation of the boiler, and (2) the spring safety-valves. These latter will fulfill all the conditions that are required of them, that is to say, the faculty of rising as soon as the pressure has reached a certain figure, of allowing enough steam to pass to keep the pressure from rising even when the fires are being stirred up, and of falling back upon their seat at a pressure very approximate to that for which the boilers have been inspected and registered.

The engine of La Normandie consists of a union of three like engines, these being compound ones, with superposed cylinders, and acting upon one shaft in common through the intermedium of three cranks set at an angle of 120°. The advantages of such an arrangement are as follows:

Superposed cylinder engines occupy a horizontal superficies of less extent than other engines do, and, as the space situated above should always be free for admission of light, ventilation, and for taking the machinery apart, there is, in sum, a diminution in the total amount of obstruction.

With three engines exactly alike, with cranks adjusted at 120°, inertia is almost completely neutralized, and the motor, whatever be the speed at which it is set running, is no longer submitted to those vibrations which jar its connections with the hold and the entire ship.

As for the compound system, its advantages as regards saving in fuel are at present so well recognized that it is useless to dwell upon them here.

The dimensions of the cylinders are as follows: diameter, 90 centimeters and 1·9 m.; stroke in common, 1·7 m. Upon Le Labrador and Le Saint Laurent the stroke is only 1·3 m. for the same diameter (1·9 m.) of the large cylinder.

The stroke in this new engine, then, is relatively greater than in the old style apparatus; and this relative increase in stroke, which has gradually been introduced into English marine engines, possesses advantages that may be considered as having been demonstrated by practice. These advantages seem to us to be as follows: The power being equal, the pressure upon the joints, and the friction that it produces, is less, since such pressure is proportional to the surfaces of the pistons. The work absorbed by passive resistances is less, and the engine revolves more easily. The size of the cylinders being equal, the surface occupied horizontally is less; and, as there is no obstruction in a vertical direction, the loss in space utilizable for passengers and freight is also less.

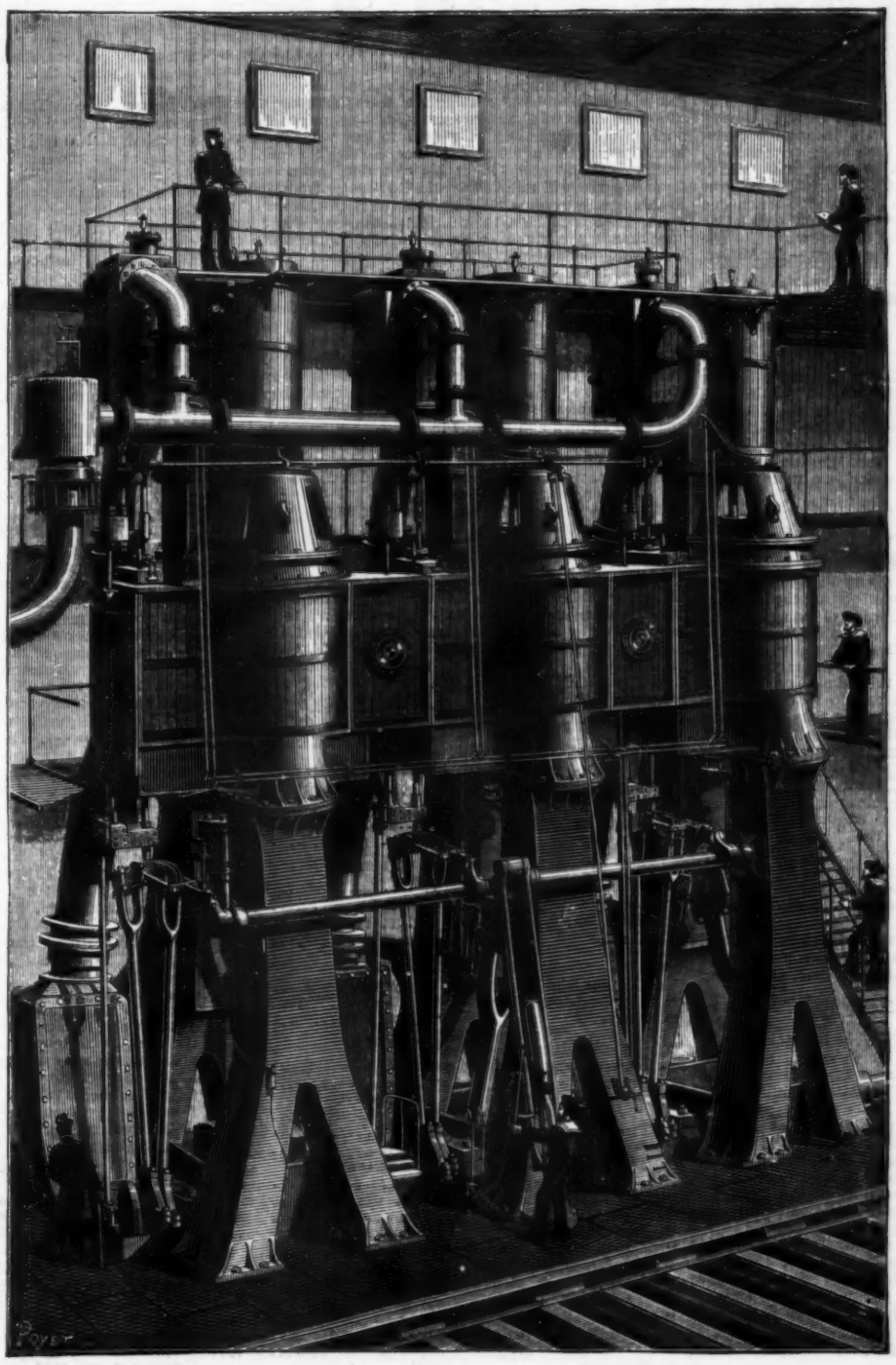
Finally, there is also a saving in steam, since the length of the dead spaces at the extremities of the stroke, being nearly a constant one, their size diminishes with the surface of the pistons.

The slide valves of the large and small cylinders are moved by the same rod, and the latter is actuated by two eccentrics united by a connecting-link. The small cylinders alone have a variable expansion, this being effected, after the Meyers system, by means of two plates sliding upon the back of the slide-valve and capable of being regulated while the engine is running and without the necessity of stopping it.

The reversing gear used in La Normandie is that of Brown. The motion is moderated by a hydraulic brake formed of a piston that moves in a cylinder full of water, whose two extremities are put in communication through an orifice of variable section. This piston is actuated, when need be, by a small hand pump, thus permitting of its being employed as a motor so as to move the slide-valves by hand when there is no steam.

Each engine has its condenser, its air-pump, and its cold water circulating pump, and is thus complete within itself, so that in case of emergency it would be possible to run the ship with a single one of the engines if the other two were disabled.

The condensers, united, give a surface of about 1,000 meters, or half the heating surface. The circulating pumps are centrifugal ones, each having its own motor. This



THE ENGINES OF LA NORMANDIE.

latter arrangement has the following advantages: In the first place the condenser may be kept cool when the apparatus is at rest, even though leaks allow steam to enter it. The engine is thus always ready to start off at once. Besides, it allows the quantity of circulating water to be varied to suit requirements, while the engine is running, in such a way as to cause condensation at a temperature that is neither too low nor too high.

We have said, at the outset, as regards the apparatus properly so called, that the three engines acted upon the same shaft through the intermedium of three connected cranks adjusted at an angle of 120°. The diameter of the shaft, which is in three pieces, is 60 centimeters. This is somewhat large, in view of the rules usually followed in England; but such oversize will have the advantage that, if it does not absolutely prevent substitutions, it will at least render them less frequent. This is a great advantage, since it is a long and costly operation to replace shafts in so powerful engines as these.

The crank shafts of La Normandie were made at the Mersey Forges. Each of them, all adjusted, weighs about 14,000 kilos, or 42,000 kilos for the entire shaft. The connecting shaft is 57 centimeters and the screw shaft 60 centimeters in diameter. The boss of the helix is of steel and is from the works of Messrs. Vickers, of Sheffield. It weighs altogether 6,000 kilos. The four blades are of manganese bronze, and weigh together about 12,000 kilos. The diameter of this propeller was limited by the draught of the vessel, this reaching 6·7 m. The pitch, which is constant, is 9·45 m. The fraction of total pitch varies from 0·15 m. at the extremity of the blades to 0·44 m. near the boss.

The thrust of the helix is transmitted to the ship through the intermedium of a bearing situated behind the engine. There is nothing more important than that this piece, which is submitted to much pressure and friction, shall not become hot, and that it shall be kept in good condition and be easy of repair. Such a result is obtained very satisfactorily in the form of bearing adopted in La Normandie. The thrust is exerted upon 10 horseshoe-shaped castings having an anti-frictional bushing, and which are inserted between the collars of the shaft, their position being regulated by nuts and jam nuts that move upon two large rods, which are fixed to the right and left side of the bearing. The lower parts of the shaft-collars dip into a lubricator. When one of the horseshoe-shaped pieces becomes hot, it can be removed and another be substituted for it, even while the vessel is under way, without touching the others.—*La Nature.*

SPECIFICATION FOR A RAILWAY LINE.

We give below a copy of a recent contract, for which we are indebted to *Engineering News*. Referring to this document, our contemporary observes:

"Our readers will note several new departures in the writing of specifications in the copy printed in this issue. The bids are to be very detailed, almost every possible condition and kind of work being fully specified, and under each head the class of work so covered by the contract price is as clearly expressed as possible, leaving little room for doubt or dispute. 'Excavation in water' is a recent classification, and a proper one.

"In requiring the embankments behind bridge abutments to be carefully rammed, the end in view is economy in masonry. The modern practice, especially as followed upon the Penna. R. R., results in walls that in the lack of thickness would have astonished the generation of engineers just passed away; but the present methods are the results of experience and observation. In replacing old masonry with a better class of work on the line of the Penna. R. R. it had been found that, with a bank solidified by years of use with *all* settlement at an end, a facing wall was practically all that was needed. Reasoning from this, abutment filling is now rammed, rolled, and often watered, to reduce the settlement to a minimum, and at the same time reduce the horizontal thrust against the wall; the result is less masonry.

"'Over-haul' is a fruitful source of difference between the contractor and the engineer; in this case, the distance to be hauled is fixed at 1,000 ft., not 1,400, as some engineers demand, and a price fixed per cubic yard per 100 ft. hauled beyond the prescribed distance; the contractor can figure accordingly upon his excavation price. Ballast must be broken to pass through a 2½-inch ring 'in any direction.' This is sufficient and usual, though we know of engineers who require a 2-inch ring to be used, resulting in waste of material and labor without a compensating result in the road bed.

"'Masonry' is described under twenty-two headings, and as a special head we have 'What the price named is to cover.' The composition of cement and lime, mortar and concrete, is fully expressed.

"Tunnel work is to be paid for by the cubic yard or lineal foot, in case the latter bid is accepted. The price is to cover all material contained between the two portals. In this these specifications stick to old time usages. Some engineers now require a classification of tunnel excavations into rock, loose rock, earth, etc. The latter practice is all very well, if the classification is exact and just; but just there is the trouble. In no case is more judgment and experience demanded on the part of the engineer.

"The specification for iron work is too meager, if bridge work is included under this head; but we imagine, from the attention to detail shown in other portions of the specifications, that a separate and distinct form is prepared for this class of work.

"Charging the contractor the cost of replacing stakes, bench marks, etc., will be the occasion of some energetic remarks on the part of those old-timers who seemed in our railroad days to take especial pains to run down our stakes, and preserved our 'plugs' by carrying them up to the shanty.

"These specifications, as exemplifying model modern practice, will well repay study."

AGREEMENT FOR GRADING CONTRACT.

Whereas, The American Construction Company, a company organized and existing under the laws of New Jersey, and hereinafter called the Construction Company, has heretofore, to wit, upon the day of August, 1883, made and entered into a certain contract with The South Pennsylvania Railroad Company, a corporation organized and existing under the laws of Pennsylvania, and hereinafter called the Railway Company, to build, construct, and complete the entire line of the railroad of the said Railway Company, from the east bank of the Susquehanna River to the west bank of the Youghiogheny River in the State of Pennsylvania, to which contract reference is hereby made, these presents being made in subordination to the terms thereof;

And whereas, The construction and completion of said railroad is desired within a period too short to permit the whole of the said work to be performed by the said Construction Company, which desires to sublet certain portions thereof;

Now, therefore, This agreement, made this day of in the year of our Lord one thousand eight hundred and eighty- between party of the first part, hereinafter called the Contractor, and the said The American Construction Company, party of the second part, witnesseth:

I. That for and in consideration of the prices, payments, and covenants herein mentioned to be paid, made, and performed by the Construction Company, the Contractor hereby covenants and agrees to construct and finish in a substantial and workmanlike manner, to the satisfaction and acceptance of the Chief Engineer and Directors of the said The South Pennsylvania Railroad Company, and in strict conformity with the annexed specifications, hereby adopted, accepted, and declared by the parties hereto to be an essential part of this agreement, the following described work upon the established line of the said Railway Company, and upon the final location thereof, in the County of in the State of Pennsylvania, viz.:

And it is mutually agreed between the said parties of the first and second parts, that:

Right of Way.—1. The right of way and the use of such lands as may be necessary to enable the said Contractor to conform to the requirements of the specifications hereto attached, shall be furnished for the construction of the said railroad by the said Construction Company, so that the work herein contracted for can be promptly commenced and prosecuted to completion.

Work Executed under Direction of Chief Engineer.—2. The work shall be executed under the supervision and direction of the said Chief Engineer of the Railroad Company (hereinafter called the Chief Engineer), who shall designate the portions of the line upon which work shall be done, and who shall, at all proper times, furnish plans, measurements, stakes, and directions for doing the work; and his classification of materials, measurements, and estimates shall be final. Oral instructions in regard to any work to be performed under this agreement, if accepted by the said Contractor, shall be accepted at his own risk, and no instructions so given will relieve the said Contractor from liability to damages or expenses arising from the performance of the work, in accordance with such instructions, or in any other way than in accordance with this agreement, and the said Construction Company hereby reserves to itself the right to accept or reject any or all work done in accordance with such instruction.

Tools, Materials, Mechanics, Laborers, etc., at Contractor's Expense.—3. The said Contractor shall, at his own expense, cost, and charge, find and provide a full and ample supply of the best and most suitable tools and appliances required to be used in the performance of the said work, and to provide the best of materials of every kind that may be needed for the thorough and expeditious execution of said work, and shall furnish and provide in sufficient numbers all mechanics, laborers, and other workmen, and also all things that may be necessary and requisite for constructing and completing, within the time herein stipulated, the whole of the work herein agreed to be done.

Contract to be Completed.—4. The work herein contracted for shall be commenced within twenty days after the date of this agreement, and shall be completed on or before the first day of A. D. 188 .

Prices.—5. For and in consideration of the true and faithful performance, by the said Contractor, of the agreements and conditions contained in this agreement and the specifications hereto attached, the said Construction Company hereby promises and agrees to pay to the said Contractor, his executors or administrators, for the work done and materials furnished as aforesaid, at the following rates and prices, to wit:

For Clearing, per acre.....$....Cts....
" Grubbing, " ....

GENERAL EXCAVATION.

For Solid Rock, per cubic yard.....$....Cts....
" Loose " " " ....
" Hard Pan, " " .....
" Earth, " " .....

EXCAVATION IN WATER.

For Solid Rock, per cubic yard .....$....Cts....
" Loose " " .....
" Hard Pan, " " .....
" Earth, " " .....

TUNNEL EXCAVATION.

For Tunnels, single track, per cubic yard ...$....Cts....
" " double " " " .....
" Shafts, " " .....

BALLAST.

For Broken stone, per cubic yard.....$ ...Cts....
" Gravel " " .....

MASONRY.

For First-Class, per cubic yard.....$....Cts....
" Second " " " .....
" Third " and Box Culvert, in cement, per cubic yard.....
" Third-Class and Box Culvert, dry, per cubic yard.....
" Arch Masonry, first-class, per cubic yard.....
" " " second-class, in cement, per cubic yard.....
" Arch Masonry, second-class, dry, per cubic yard.....
" Slope Walls, per cubic yard.....
" Stone Paving, in cement, per cubic yard.....
" " " dry, " " .....
" Concrete, " " .....
" Brick Work, " " .....
" Packing, in cement, " " .....
" " dry, " " .....
" Rip Rap, " " .....

DRAIN PIPE.

For 12-inch, per lineal foot.....$ ...Cts....
" 15 " " " .....
" 18 " " " .....

FOUNDATION TIMBER.

For White Oak, per 1,000 ft., B. M.....$....Cts....
" Hemlock, " " " .....

TRESTLE TIMBER.

For White Oak, per 1,000 ft., B. M.....$....Cts....
" Hemlock, " " " .....

TUNNEL TIMBER FOR PERMANENT SUPPORTS.

For White Oak, per 1,000 ft., B. M.....$....Cts....
" Hemlock, " " " .....

PILING.

For White Oak, per lineal foot.....$....Cts....
" Hemlock, " " .....

IRON WORK.

For Wrought, per pound.....$ ... .
" Cast, " .....

SUPPLEMENTAL—TUNNEL WORK.

For single track, with arch, per lineal foot, completed .....$....Cts....
For single track, with arch and side walls, per lineal foot, completed.....$ ...Cts....
For single track, without masonry, per lineal foot, completed.....$ ...Cts....
For double track, with arch, per lineal foot, completed. .....$....Cts....
For double track, with arch and side walls, per lineal foot completed. .....$ ...Cts....
For double track, without masonry, per lineal foot, completed.....$....Cts....

Monthly Estimates and Payments.—6. During the progress of said work, so long as the terms of this agreement shall be complied with by the said Contractor, the said Construction Company shall make payments to said Contractor, on or about the fifteenth day of each month, for he work done during the previous month, said work to be estimated and certified to by the said Chief Engineer to be in accordance with this agreement, less, however, a reservation of fifteen (15) per cent. thereof, which shall remain in the hands of said Construction Company as an agreed compensation for damages, to be retained for ever by the said Construction Company, in case the whole work herein contracted to be performed is not done in accordance with this agreement; provided that a larger and sufficient amount may, at the discretion of the said Chief Engineer, or the Directors of the said Railway Company, be retained to protect the said Construction Company against the overpayment for work done, as compared with that remaining to be done, it being, however, expressly understood that it will be wholly discretionary with the said Construction Company to make any payments on account of materials delivered, and not permanently applied to the work for which they may have been intended.

Final Estimate and Payment.—7. When this agreement shall have been completely performed on the part of the said Contractor, the said Chief Engineer shall make a final estimate of the quantity, quality, and value of the work done, according to the terms of this agreement, and the said Construction Company shall, within ninety (90) days thereafter, pay to the said Contractor, upon his giving a release under seal to the said Construction Company from all claims or demands whatsoever growing in any manner out of this agreement, all sums of money then remaining due and unpaid upon the work performed under this agreement, after first deducting therefrom any and all sums herein provided to be retained by the said Construction Company.

Chief Engineer not to be Bound by Previous Estimates.—8. In computing the said final estimate, and giving his final certificate, the said Chief Engineer shall not be bound by any preceding estimates and certificates, but such preceding estimates and certificates shall be held to be only approximative to the final estimate, and the said monthly estimates and certificates on unfinished work shall in no case be taken as an acceptance of the work, or a release of the said Contractor from responsibility therefor, until the final estimate is made, and the work in its entirety is accepted as complete under this agreement.

II. And it is further distinctly understood and agreed:

Sub-Contracts.—1. The said Contractor shall not assign or sublet the whole or any part of this agreement (excepting only for the supply of materials and plant), without having first obtained the consent in writing of the said Construction Company thereto.

Action in Case of Non-Performance of Contract.—2. If at any time during the progress of the work, it should appear by report of the said Chief Engineer that the force employed, the quantity or quality of the tools, appliances, or workmen provided, or that the progress or character of the work, or materials furnished, are not respectively such as, in the opinion of the said Chief Engineer, will insure the completion of the work under this agreement, within the time stipulated, or are not in accordance with the specifications annexed hereto, then, and in that case, the said Construction Company may serve written notice on the said Contractor to at once supply such increase of force, appliances, or tools, and to cause such improvement in the character of the work or materials to be made, as may be required to make the same conform to the stipulations of this agreement and specifications; and if, on the expiration of ten (10) days after the service of such written notice upon the said Contractor, personally or by leaving the same at his office or last known place of residence, the said Contractor shall have failed to furnish to the said Construction Company satisfactory evidence of his efforts, ability, and intention to furnish the desired improvements and remedy the specified deficiencies, the said Construction Company may thereupon enter on and take possession of the said work, or any part thereof, with the tools, material, plant, appliances, houses, machinery, and other appurtenances thereon, and hold the same as security for any or all damages or liabilities that may arise by reason of the non-fulfillment of this agreement within the time herein stipulated; and furthermore, may employ the said tools, materials, etc., as aforesaid, and such other means as the said Construction Company may deem proper to complete the work, at the expense of the said Contractor, and may deduct the cost of the same from any payments then due, or thereafter falling due, to the said Contractor; and in case the said Contractor shall not complete the said work within the time herein specified, and the said Construction Company shall, notwithstanding such failure, permit the said Contractor to proceed with, or complete the said work as if such time had not elapsed, such permission shall not be deemed a waiver in any respect, by the said Construction Company, of any forfeiture of liability for damages, or expenses thereby incurred, arising from such non-completion of the said work within the time specified, but such forfeiture or liability shall still continue in full force against the said Contractor, as if such permission had not been granted. And it is further distinctly understood and agreed that time, whenever involved in this agreement, is of the essence of this agreement.

Action in Case of Non-Payment of Wages.—3. In all cases of non-payment by the said Contractor of any sum or sums

of money due the laborers or other workmen, for work performed under this agreement, the said Construction Company is hereby authorized to pay such laborers or workmen the amounts due and owing to them by the said Contractor; and if any action or proceeding at law or in equity shall be instituted, by virtue of any law or statute now in force, or hereafter enacted, for labor and wages on said work, the said Construction Company may pay all damages, wages, recoveries, costs, expenses, and counsel fees arising therefrom, and deduct the same, and also what amounts may be paid for wages as before mentioned, from any moneys due or to grow due to the said Contractor; and the said Construction Company may, from time to time, retain such reasonable sums as it may deem necessary for its protection in its behalf, and the said Contractor shall pay the deficiency arising therefrom upon demand.

Incompetent or Riotous Employes.—4. The said Contractor shall discharge any foreman or other employe, who shall, in the judgment of the said Chief Engineer, be unfaithful, unskillful, or remiss in the performance of his work, or guilty of riotous, disrespectful, or otherwise improper conduct; and no person so discharged upon this work, or any other work done for the said Construction Company, shall be employed again by the said Contractor, upon the work to be done under this agreement, without the written consent of the said Chief Engineer.

Intoxicating Liquors.—5. The use or sale of ardent spirits or other intoxicating beverages upon the work, or in any of the buildings, boarding houses, or other tenements owned, occupied, or within the control of the said Contractor or any of his employes, is strictly forbidden, and the said Contractor shall exercise his influence and authority to their utmost extent to secure compliance with this regulation.

Responsibility for Violation of Laws and Injury to Persons or Property.—6. In all operations connected with the work embraced in this agreement, the said Contractor shall be held responsible for any failure to respect, adhere to, and comply with, all local ordinances and laws controlling or limiting, in any way, the actions of those engaged upon the work, or affecting the materials, or the transportation or deposition of them. And the said Contractor hereby assumes all liability for, and agrees to indemnify the said Construction Company against all loss, cost or damages for or by reason of any liens, claims, or demands for materials, or from laborers, mechanics and others, and from any damages arising from injuries sustained by mechanics, laborers, or other persons, by reason of accidents or otherwise, and from damages sustained by depositing materials to public injury, or the injury of any person or corporation, including costs and expenses of defense, provided that he be duly notified of the bringing of suits in such cases, and be permitted to defend the same by h own counsel if he should so elect.

Temporary Fences and Roadways.—7. Where the line of the railroad passes through farms, the said Contractor shall keep up such temporary fences as may be necessary for the preservation of the crops thereon. The said Contractor shall be responsible for any damages that may be done by him or his workmen, during the performance of this work, to property adjacent to the line, in consequence of his or their unskillfulness or negligence; and if any such damage shall be done, the said Chief Engineer shall have the right to settle and pay the same, and deduct the amount thereof from the payments to be made upon his estimates. Whenever any work herein embraced shall in any manner interfere with a public or private traveled road, the said Contractor shall keep a temporary roadway, during such interference, at all times unobstructed and safe for travel, and any damages which may result from failure so to do, may be settled and withheld as above, until paid by the said Contractor.

Extra Work.—8. If any work should be required to be done by the said Construction Company, which is not now contemplated or provided for in this agreement and specifications, the said Chief Engineer shall fix the price for the same, and the said Contractor shall abide by such price, provided it be not less than the contract price for such class of work.

Chief Engineer may alter Line, Location, etc.—9. The said Chief Engineer shall have the right to make any alterations that may be hereafter determined upon by him as necessary or desirable in the location, line, grade, plan, form, or dimensions of the work, either before or after the commencement of the same, defining them in writing, and by or without drawings; and in case such alterations increase the quantities, the said Contractor shall be paid for such excess at the contract rates herein specified; but should such alterations diminish the quantity or extent of the work to be done, they shall not, under any circumstances, be construed as constituting, and shall not constitute, a claim for damages, nor shall any claim be made on account of anticipated profits on the work that may be altered or dispensed with, the intent of this provision being that only the work absolutely done shall be paid for, and at the prices named in this agreement.

Claim for Extra Work.—10. No claim for extra work shall, under any circumstances, be made, allowed, or considered, unless the same shall have been done in pursuance of an order giving in writing by the said Chief Engineer, but nothing shall be deemed or construed as extra work which can be classified, measured, and estimated under the terms of this agreement.

Allowance for Delays.—11. No extra compensation shall be made to the said Contractor for hinderances or delays from any cause in the progress of any portion of the work performed under this agreement; but if such delays or hinderances arise from any cause other than the fault of the said Contractor, then, and in that case, the said Contractor shall be entitled to such an extension of time for the completion of his contract as shall, in the opinion of the said Chief Engineer, be sufficient to compensate for any such detention, provided the said Contractor shall give notice, in writing, to the said Construction Company of such hinderances and delays, stating the cause thereof, within twenty-four hours after the same shall first occur.

Right to Suspend Work.—12. The said Construction Company reserves the right to suspend or terminate the work embraced in this agreement for reasons not herein specified, and the said Contractor hereby agrees to discontinue all work within ten days after receiving notice of such suspension or termination, in which case the said Contractor shall be entitled to payment in full for all materials actually handled or supplied, but shall make no claim for consequential damages or anticipated profits upon work not actually performed, or damage of any kind resulting from such suspension or termination.

Repairs in Case of Defective Work.—13. Any replacements or repairs rendered necessary upon or about the work herein contracted for, by reason of defective material or workmanship furnished or performed by the said Contractor, shall be made by the said Contractor upon demand, without cost or expense to the said Construction Company.

Chief Engineer to Settle Disputes.—14. All questions, differences, or controversies which may arise between the parties hereto in regard to any work to be done under this agreement, whether as to its performance or non performance, or in any way whatever pertaining to or connected with the said work, shall be referred to the said Chief Engineer, and his decision shall be in the nature of an award, and be final and conclusive upon both parties, unless the same shall be reversed or modified by the Board of Directors of the Railway Company upon appeal by either party.

In witness whereof, the said Construction Company has caused its corporate seal to be hereunto affixed, and these presents to be signed by its President and attested by its Secretary, and the said Contractor has hereunto set his hand and seal the day and year first above written.

President of the American Construction Company.

Attest:

Secretary of the American Construction Company.

Witnesses:

_____ _____ [L. S.]
_____ _____ [L. S.]
_____ _____ [L. S.]
_____ [L. S.]

Contractor.

State of .....
.....of..... } ss.:
County of.....

On this day 188 , before me personally appeared
to me known to be the person described in and who executed the foregoing agreement, and acknowledged that executed the same.

.....

SPECIFICATIONS FOR GRADING.

Grading.—Under this head shall be included clearing and grubbing, all open excavations, tunnels, and embankments required for the foundation of the road-bed, turn-outs, sidings, and station grounds, cutting all ditches about or contiguous to the road, masonry, foundation pits, planking, piling, pumping, bailing, changing of water courses, the reconstruction of mill races, highways, and byways in cases where they are interfered with or destroyed in the formation of the railroad, and all excavations and embankments in any way connected with or incident to the construction of the said railroad.

Clearing.—The lands of the said Railway Company shall be cleared, to the extent required by the said Chief Engineer, of all trees, bushes, logs, and other perishable materials, which shall be destroyed by burning, or deposited in heaps, as the Chief Engineer may direct. Large trees must be cut not more than two and one-half (2½) feet from the ground, and under embankments less than four (4) feet high they shall be cut close to the ground. All small trees and bushes shall be cut close to the ground.

Clearing shall be estimated and paid for by the acre or fractions of an acre.

Grubbing.—All stumps, roots, logs, and other obstructions shall be grubbed out and removed from all places where embankments occur less than two (2) feet in height; also from all places where excavations occur; and from such other places as the Chief Engineer may direct.

Grubbing shall be estimated and paid for by acre or fractions of an acre.

Excavations.—Excavations shall be classified under the following heads, viz.: Solid Rock, Loose Rock, Hard Pan, Earth, and Excavation in Water.

Solid Rock.—Solid rock shall include all rock found in ledges, and detached masses exceeding one (1) cubic yard, each, which, in the judgment of the said Chief Engineer, may be best removed by blasting.

Loose Rock.—Loose rock shall include all kinds of shale, soapstone, and other rock which, in the judgment of the said Chief Engineer, can be removed with pick and bar; also detached stones of less than one (1) cubic yard and more than one (1) cubic foot.

Hard Pan.—Hard pan shall consist of tough, indurated clay, or cemented gravel, which requires blasting, or other equally expensive means for its removal, or which cannot be plowed with less than four horses and a railroad plow, or which requires two pickers to a shoveler, the said Chief Engineer to be the judge of these conditions.

Earth.—Earth shall include all materials of an earthly nature, of whatever name or character, not unquestionably Rock or Hard Pan, as above defined.

Excavation in Water.—Excavation in water shall apply to foundation pits under water and deepening of channels in running water; it must include drainage, bailing, pumping, and all materials and labor connected with such excavations; also the necessary dressing of the rock for base course of masonry. The materials removed from excavations in water shall be classified and determined in the same manner as materials removed from other classes of excavations, viz.: as Solid Rock, Loose Rock, Hard Pan, and Earth.

Embankments.—Embankments shall be of such dimensions and slope as the said Chief Engineer may direct; they shall be made in accordance with his instructions, and of materials which in his judgment are suitable; they shall be carried to such height above grade as the said Chief Engineer may deem necessary to provide for shrinkage, compression, washing, drainage, and settlement, and they must be maintained to their proper height, width, and shape, until accepted by the said Chief Engineer. No large stones will be allowed within a depth of at least two (2) feet below grade, and the best materials must in all cases be reserved for finishing and dressing the surfaces. Whenever the embankment is made from side ditches, such ditching and the crest of the slopes thereof shall in no case approach within ten (10) feet, nor within double the depth of the ditch of the foot of the embankment slopes, and the slope of the excavation next to the embankment shall not be steeper than the slope of the embankment. The width of berme left at the foot of the slopes shall, in all cases, be such as the said Chief Engineer may direct. Whenever new water courses or channels for rivers or streams are required to be formed, they shall be put at such distance from the foot of the slopes as the said Chief Engineer may direct.

No perishable materials will be allowed in embankment; all proper materials taken from the excavations on the line of the railroad shall be moved into embankments, and shall be measured only as excavation, and, when directed by the said Chief Engineer, all surplus materials shall be used in widening embankments, in such manner as he shall direct.

Embankments about masonry shall be built at such times and in such manner and of such materials as the said Chief Engineer may direct.

Embankments at Bridges and Culverts.—Embankments shall not be carried forward in the usual way within fifty (50) feet of any piece of masonry finished or in progress, counting from the bottom of the slopes, but, in every such case, the earth shall be wheeled to the walls or abutments, and carefully rammed to such width and depth, and in such manner, as the said Chief Engineer may direct, when the embankment may be carried on as usual. For the work of wheeling and ramming efficiently the earth around any piece of masonry an additional price shall be paid, to be fixed by the said Chief Engineer.

Borrow Pits and Spoil Banks.—In all cases where the excavations are insufficient to make the embankments, the deficiency shall be supplied by widening excavations, or from borrow pits, to be furnished by the said Construction Company, as the said Chief Engineer may direct, and all such borrow pits shall be drained and sloped as the said Chief Engineer may direct.

Any surplus rock and earth taken from the excavations, not required for embankments, masonry, rip rap, ballast, or other purposes, may, at the discretion of the said Chief Engineer, be deposited in a regular manner on either side of the excavation in such a manner as to intercept the drainage of surface water from flowing into the road-bed and side ditches, leaving a berme of not less than ten (10) feet between the spoil bank and the top line of the excavation slopes; but spoil banks in embankments shall in no case be raised above the grade level of the road-bed.

All materials taken from excavations which, in the judgment of the said Chief Engineer, may be of greater value to the said Construction Company for other purposes than embankments, and also all timber removed from the line of the railroad, shall be considered the property of the said Construction Company, and shall be deposited in convenient positions, under the direction of the said Chief Engineer.

Ditches.—In clay cuts ditches shall be dug along the foot of the slope, of such dimensions as the said Chief Engineer may direct. To protect the cuts from washing, ditches shall be dug above the cutting, upon ground sloping toward the cuts, and connected with the embankment ditches, when directed by the said Chief Engineer; and if the material from such ditches is wasted, it shall be deposited between the ditch and the cut. Ditches shall also be dug in other places and for other purposes, when so directed by the said Chief Engineer.

Measurement of Excavations.—Materials shall be measured in excavations whenever possible, and the term "Excavation" shall include all cuttings, borrow pits, roadways, changes of water courses, ditches, foundation, and trestle pits, and, in fact, every kind of excavation at the time required. Wherever the excavations are left in such shape that they cannot well be measured, the said Chief Engineer may measure the materials in embankment; but in such case he shall deduct from the amount actually measured ten (10) per cent. for wheel barrow and shovel work, and five (5) per cent. for scraper and team work, to cover loss from shrinkage when measured before the embankment has had time to settle.

Excavation, How Estimated and Paid For.—Excavation, in all the several classes thereof, shall be of such dimensions and slope as the said Chief Engineer may direct, and shall be estimated and paid for by the cubic yard.

Over Haul.—The price paid for excavation, in all the several classes thereof, shall be understood to cover and pay for the entire expense of its removal by any method whatever, including loading, unloading, transportation to and deposit, in the manner prescribed in these specifications, in the places designated by the said Chief Engineer, provided the necessary haul of the material so transported does not exceed one thousand (1,000) feet; beyond that distance, one (1) cent per cubic yard per one hundred (100) feet shall be allowed and paid for such necessary extra haul.

Ballast.—When so directed by the said Chief Engineer, the said Contractor shall be required to ballast the entire length of his section or sections one (1) foot deep above the grade, neatly and truly leveled, and lined up to such widths and end slopes as the said Chief Engineer may prescribe. The material shall be either gravel or broken stone.

Gravel must be clean, free of clay, earth, loam, and stones larger than will pass through a two and one-half (2½) inch ring in any direction; it must not contain more than one-third (⅓) sand, and shall be subject to the inspection and acceptance of the said Chief Engineer.

Broken stone must be of good, hard, durable stone, selected by the said Chief Engineer, and must be broken or crushed into fragments not larger than will pass through a two and one-half (2½) inch ring in any direction, and be perfectly clean and free from all dirt, or any other earthy admixture, before being spread on the road-bed.

Stone ballast shall under no circumstances be allowed to be broken in place on the road-bed, but must be broken in clean places, specially prepared for that purpose, and laid up in piles, to be hauled and spread on the road bed, after the grade surface has been prepared for it.

When good material for ballast is found in the excavations on the line of the railroad, and does not require breaking, the said Chief Engineer may require the road-bed to be raised one (1) foot above grade with this material, and the said Contractor shall be paid for the material so handled at the same rates as for excavation of material of the same class.

Ballast shall be estimated and paid for by the cubic yard, and the price paid shall include hauling, placing, and spreading, as herein directed.

MASONRY.

All stone used for the different classes of masonry must be secured by the said Contractor, and must be sound, durable, and not liable to be affected by the weather, and shall be subject to the approval of the said Chief Engineer.

Masonry shall be classified as follows, viz.:

First-Class Masonry.—First-class masonry shall consist of range rock work of the best description. The face stones shall be accurately squared, jointed, and bedded, and laid in regular horizontal courses of not less than ten (10) inches in thickness, decreasing in thickness regularly from the bottom to the top of the walls. They will consist of headers and stretchers, and there shall be at least one (1) header to every two (2) stretchers, and they shall be so laid that, as nearly as practicable, the headers in each course shall divide equally, or nearly so, the space between the headers in the course immediately below.

Stretchers shall be not less than three (3) feet in length and eighteen (18) inches in width.

Headers shall be not less than three (3) feet in length and eighteen (18) inches in width, and shall hold the size back into the heart of the wall that they show in its face.

When the walls do not exceed four (4) feet in thickness the headers shall run entirely through, and when they exceed that thickness there shall be as many headers of the same size in the rear as in the front of the wall, so arranged that a header in the rear of the wall shall be between two headers in the front.

Every stone must be laid on its natural bed, and all stones must have their beds well dressed and made always as large as the stone will admit of. Mortar joints shall not exceed one-half (½) inch in width; the vertical joints of the face must be in contact at least four (4) inches, measured in from the face, and as much more as the stone will admit of. All corners and batter lines must be run with a neat chisel draught of one and one-half (1½) inches on each corner, and the projections of the rock face must not exceed three (3) inches beyond the face or draught lines of the stones. In tunnel side walls this projection must not exceed two (2) inches. The stones of each course shall be so arranged as to form a proper bond with the stones of the underlying course, and a bond of less than one (1) foot shall in no case be allowed. The whole of the masonry shall be laid in cement mortar, each stone being carefully cleaned and dampened before setting, and each course shall be thoroughly cemented before the succeeding course is laid. No hammering on the wall will be allowed after the course is set. If any inequalities occur, they must be carefully pointed off.

Backing.—The backing shall consist of stones with beds dressed to one-half (½) an inch, and of a thickness not less than one-half (½) that of the corresponding face stones. They shall be laid in full cement mortar beds, so as to break joints and thoroughly bond the work in all directions, and on the completion of each course the spaces between the larger backing stones—none of which spaces shall be over six (6) inches wide—shall be filled with small stones and spalls thoroughly bedded in cement.

Foundation Courses.—All foundation courses must be laid with selected large, flat stones, not less than twelve (12) inches in thickness, nor of less superficial surface than fifteen (15) square feet.

Coping Courses.—All bridge seats and tops of walls shall be finished with a coping course of such dimensions and projection as may be ordered by the said Chief Engineer, dressed and cut to a true surface on top and on the showing faces, in conformity with diagrams for the same, which shall be furnished by the said Chief Engineer.

Second-Class Masonry.—Second-class masonry shall consist of broken or random range rock work of the best description. The face stones shall be dressed to a uniform thickness throughout before being laid, but not hammered, and shall be laid with horizontal beds, and vertical joints on the face. And no stone shall be less than eight (8) inches in thickness, unless otherwise directed by the said Chief Engineer. There shall be at least one (1) header to every three (3) stretchers, and both headers and stretchers shall be of similar size, when the thickness of the wall will admit, but neither shall be less than three (3) feet in length and fifteen (15) inches in width. The same arrangement of headers shall be required as is specified for first-class masonry. Mortar joints shall not exceed three-quarters (¾) of an inch in thickness. All corners and quoins shall have hammer-dressed beds and joints. All corners and batter lines shall be run with an inch and one-half chisel draught. The vertical joints of the face must be in contact at least four (4) inches, measured in from the face, and as much more as the stone will admit of.

The work need not be laid up in regular courses, but shall be well bonded. The stones shall be cleaned and dampened before setting and shall be laid in cement mortar.

Backing.—The backing shall consist of stones not less than six (6) in. thick (at least one-half (½) of which shall measure two (2) cubic feet), laid in full cement mortar beds, with good joints and bonds, and the spaces filled with spalls thoroughly bedded in cement, as specified for first-class masonry.

Coping Courses.—Bridge seats and tops of walls shall be coped in the same manner as specified for first-class masonry.

Foundation Courses.—Stones in foundation courses shall be of not less than twelve (12) inches in thickness and ten (10) square feet of surface.

Third-Class and Box Culvert Masonry.—Third-class masonry shall be laid dry, or in lime or cement mortar, according to the direction of the said Chief Engineer.

It shall be formed of good quarry stones, laid upon their natural beds, and roughly squared on the joints, beds, and faces, the stones breaking joints at least six (6) inches and with at least one (1) header for every three (3) stretchers. No stones shall be used in the face of the wall less than six (6) inches thick or less than twelve (12) inches on the least horizontal dimension. Headers shall be at least three (3) feet long, or extend entirely through the wall. The ends of all walls shall be dressed, and either stepped to correspond with the slope of the embankment or finished with a cross-head wall, as the said Chief Engineer may direct.

Foundation.—The stones in the foundations must be not less than ten (10) inches in thickness, and shall contain not less than ten (10) square feet of surface, and each shall be firmly, solidly, and carefully laid.

Box Culverts.—In box culverts the top course shall extend entirely across the wall, and the covering stones shall have a bearing of at least one (1) foot on each wall. The covering stones shall be not less than ten (10) inches thick for two (2) foot culverts, than twelve (12) inches thick for three (3) foot culverts, or than fifteen (15) inches thick for four (4) foot culverts. When covering stones cannot be obtained the said Chief Engineer may require a rubble arch to be substituted for it, which shall be paid for at the same rate as other third-class masonry.

Drain Pipe.—In localities where but a small quantity of water passes, drain pipe shall be substituted for culverts when so ordered by the said Chief Engineer. Sizes of twelve (12) inches, fifteen (15) inches, or eighteen (18) inches diameter to be used as directed by the said Chief Engineer, and the quality must be the best of Scotch vitrified pipe, or if other kinds are used must be in quality fully equal in every respect to the Scotch, and be subject to the approval of the said Chief Engineer. Drain pipe shall be estimated and paid for by the lineal foot. Drain pipes must be well and carefully bedded and laid, and in accordance with the instructions of the said Chief Engineer.

Arch Masonry, First-Class.—Arch masonry, first-class, shall be laid in cement mortar, and shall be built in accordance with the specifications for first-class masonry, when and to the extent that the said Chief Engineer may direct.

Ring Stones and Arch Sheeting Stones.—The ring stones shall be dressed to such size and shape as the said Chief Engineer shall determine. The ring stones and arch sheeting stones shall be of not less thickness than ten (10) inches on the intrados of the arch, and shall be dressed with three-eighths (⅜) inch joints, and shall be of the full depth specified by drawings or otherwise for the thickness of the arch. The joints must be made on truly radial lines, and the face of the sheeting stones must be dressed to make close joints. The ring stones and arch sheeting stones shall break joints not less than one (1) foot.

Wing Walls.—The wing walls shall be neatly stepped, in accordance with the drawings furnished, with selected stones the full width of the wing and not less than ten (10) inches thick, and no stone shall be covered less than eighteen (18) inches by the one next above it. The wing walls may be finished with a neatly capped newel at end of wing, and a string coping course on the wing when so decided by the said Chief Engineer.

Parapets.—The parapets shall be finished with a coping course of full width of parapet, with such projection as may be directed by the said Chief Engineer, the stone to be not less than ten (10) inches in thickness.

Arch Masonry, Second-Class.—Arch Sheeting Stones.—Arch masonry, second-class, shall be laid in cement mortar, or dry, as the said Chief Engineer may direct, and shall be of the same general character and description as second-class masonry, with the exception of the arch sheeting, for which proper stones shall be selected that shall have a good bearing throughout the thickness of the arch, and shall be well bonded and be of the full depth of the arch. No stone shall be less than six (6) inches in thickness on the intrados of the arch.

Ring Stones.—The ring stones of all arches shall conform to the specifications for first-class arch masonry.

Retaining Walls.—Retaining walls shall be classified as second or third class masonry, laid dry, as may be ordered in each particular case.

Slope Walls.—Slope walls shall be of such thickness and slope as directed by the said Chief Engineer. The stones must reach entirely through the wall, and be not less than four (4) inches thick and twelve (12) inches long; the joints must be close and free from spalls. The foundations must be prepared and laid as directed by the said Chief Engineer.

Stone Paving.—Stone paving for culverts and other water courses shall be made by setting stone from eight (8) to fifteen (15) inches deep on edge, laid either dry or in strong cement mortar, as may be directed by the said Chief Engineer.

Rip Rap.—When required by the said Chief Engineer, the said Contractor shall protect the face of embankments, or the foot of slopes, from the action of water by a facing of rip rap of stone, or of brush and stones, or by a retaining wall, as may be directed. The rip rap, when used, shall be laid by hand, by competent workmen, and shall be of such thickness and slope and of such ordinary stone as the said Chief Engineer may direct.

Brick Masonry.—Brick masonry must be laid with the best quality of all hard-burned brick, well tempered and moulded to standard size. No bats, cracked, crooked, or salmon bricks, under any circumstances, will be allowed in the work. The bricks shall be well soaked in water before being laid, and shall be laid in the best hydraulic cement mortar, with such thickness of joint and style of bond as shall be prescribed by the said Chief Engineer.

Grout.—Grout shall be substituted for mortar when ordered by and to such an extent as may be desired by the said Chief Engineer.

Brick Arching—Keying of Arches—Packing.—Brick arching must be coated on the back with a coating of strong cement mortar one (1) inch in thickness; and in tunnel arching, wherever a seam of water is met, the arch must be covered over with roofing felt, or a course of asphaltum applied hot, of such thickness as may be directed by the said Chief Engineer, and this covered again with plastering of cement mortar, so as to make the arch impervious to water, a drainage channel properly formed being left for it in the backing of the arch and side walls, with suitable openings left for its escape at such points and of such size as may be directed by the said Chief Engineer. Where roofing felt or asphaltum is ordered by the Chief Engineer to be used, a price shall be fixed by him for the same. The keying of all arches shall be most carefully done, in such manner as may from time to time be directed by the said Chief Engineer. The packing between the arch and tunnel roof, over any section of the arch, shall never be done until the section has had at least forty-eight (48) hours for setting after being keyed.

Price to Cover What.—The price per cubic yard for masonry and brick work shall include the furnishing of all materials, scaffolding, centering, and all other expenses necessary to the construction and completion of the masonry or brick work, and the maintenance of the same until the work is accepted.

Cement.—Cement must be of the best quality of freshly-burned and ground hydraulic cement, and be equal in quality to the best brands of "F. O. Norton's cement." It shall be subject to test made by the said Chief Engineer, or his appointed inspector, and must stand a proof tensile test of fifty (50) lb. per square inch of sectional area on specimens allowed a set of thirty (30) minutes in air and twenty-four (24) hours under water.

Cement Mortar.—Cement mortar shall in all cases be made of one (1) part in bulk of the best hydraulic cement to two (2) parts in bulk of clean, sharp sand, well and thoroughly mixed together in a clean box of boards before the addition of the water, and must be used immediately after being mixed. No mortar left over night will, under any pretext, be allowed to be used. The sand and cement used shall at all times be subject to inspection, test, acceptance, or rejection by the said Chief Engineer.

Lime Mortar.—Lime mortar (which in all cases shall contain cement) shall consist, unless otherwise directed by the said Chief Engineer, of two parts of best quicklime, one of cement, and five of sand; the ordinary mortar of lime and sand being first properly made, and the cement thrown in and thoroughly mixed before using.

Concrete.—Concrete shall be composed of fragments of hard, sound, and acceptable stone, broken to a size that will pass through a two (2) inch ring in any direction, thoroughly clean and free from mud, dust, dirt, or any earthy admixture whatever; mixed in the proportion of three (3) parts in bulk of the broken stone to one (1) part of freshly made cement mortar of the quality herein described. The broken stone is to be well watered and the stone and mortar thoroughly turned and mixed on a tight plank floor immediately before using, until every stone is coated with the mortar; concrete is to be quickly laid in sections and in layers not exceeding nine (9) inches in thickness, and to be thoroughly rammed until the mortar flushes to the surface; it shall be allowed at least twelve (12) hours to set before any work is laid on it. Concrete may be substituted for masonry in foundations and backing and arch culverts when so ordered by the said Chief Engineer.

Pointing.—The showing joints of all classes of masonry laid in cement must be neatly pointed with cement mortar, finely tempered; but the pointing of joints that have no existence will not be allowed.

General Provisions.—Brick masonry may at all times be substituted for stone when so ordered by the said Chief Engineer.

No masonry of any kind must be covered up until it has been inspected and accepted by the said Chief Engineer.

All masonry shall be built according to the plans and instructions furnished by the said Chief Engineer, and the several classes thereof shall be estimated and paid for by the cubic yard, computing only the actual solidity thereof required by the plans and layout.

No constructive or conventional measurement will be allowed, any rule or custom in the section of the country through which the road passes to the contrary notwithstanding.

All materials shall be subject to rigid inspection, and any that have been condemned must be removed from the site of the work immediately. No masonry will be allowed to be laid in freezing weather. All masonry shall be subject to the supervision of an inspector, whose duties shall be to see that the requirements of these specifications are conformed to, but his presence is in no way to be presumed to lessen in any degree the responsibility of the said Contractor or his obligations.

No allowance will be made for timber, or work on same, used in scaffolding, shoring or centering for arches, excepting only timber furnished for sheet piling, or foundation timbers or plank, necessarily, and by order of the said Chief Engineer, left in the ground.

FOUNDATIONS.

General Description.—Foundations for masonry shall be excavated to such depths as may be necessary to secure a solid bearing for the masonry, of which the said Chief Engineer shall be the judge. The materials excavated shall be classified and paid for, as provided for in these specifications, under the general head of Excavations; and in case of foundations in rock, the rock must be excavated to such depth and in such form as may be required by the said Chief Engineer, and must be dressed level to receive the foundation course.

When a safe and solid foundation for masonry cannot be found at a reasonable depth (to be judged of by the said Chief Engineer), there shall be prepared by the said Contractor such artificial foundations as the said Chief Engineer may direct. All materials taken from the excavations for foundations, if of proper quality, shall be deposited in the contiguous embankment; but any material unfit for such purpose shall be deposited outside the roadway, or in such a place as the said Chief Engineer shall direct, and so that it shall not interfere with any drain or water-course.

Timber—Iron Work.—Timber foundations, when required, shall be such as the Chief Engineer may by drawings or otherwise prescribe, and shall be paid for by the one thousand (1,000) feet, board measure, the price covering cost of material, framing, and putting in place. All wrought and cast iron work ordered by the said Chief Engineer shall be paid for by the pound, the price including cost of material, manufacture and placing in the work.

Piling.—All timber used in foundations or foundation piling shall be of young, sound, and thrifty white oak, yellow pine, or other timber equally good for the purpose, acceptable to the said Chief Engineer. Piles must be at least 8 inches in diameter at the small end and 12 inches in diameter at the butt when sawn off; they must be perfectly straight and trimmed close, and have the bark stripped off before they are driven. They must be driven into hard bottom until they do not move more than ½ inch under the blow of a hammer weighing 2,000 pounds, falling 25 feet at the last blow. They must be driven vertically, and at the regular distances apart from centers, transversely and longitudinally, as required by the plans or directions of the said Chief Engineer; they must be cut off squarely at the butt, and be well sharpened to a point, and when necessary, in the opinion of the said Chief Engineer, shall be shod with iron and the heads bound with iron hoops of such dimensions as he may direct, which shall be paid for the same as other iron work used in foundations.

The necessary length of piles shall be ascertained by driving test piles in different parts of the localities in which they are to be used; and in case a pile shall not prove long enough to reach hard bottom, it shall be sawed off square, and a hole two (2) inches in diameter be bored into its head twelve (12) inches deep; into this hole a circular white oak treenail twenty-three (23) inches in length shall be driven, and another pile, similarly squared and bored, and of as large a diameter at the small end as can be secured, shall be placed upon the lower pile, brought to its proper position, and driven as before directed. All piles, when thus driven to the required depth, are to be cut off truly square and horizontal at the proper height given by the said Chief Engineer, and only the actual number of lineal feet of the piles left for use in the foundations after being sawn off shall be paid for.

Coffer Dams.—Where coffer-dams are, in the opinion of the said Chief Engineer, required for foundations, the prices provided in the contract for timber, piles, and iron in foundations shall be allowed for the material and work on same, which are understood as covering all risks from high water or otherwise, draining, bailing, pumping, and all materials connected with the coffer-dams. Sheet piling shall be classed as plank in foundations, and shall be paid for by the one thousand (1,000) feet, board measure, if left in the ground.

TRESTLE WORK.

Trestle work shall include all wooden structures commonly used as substitutes for abutments and piers, and for farm passes, etc. These shall be built, according to the plan furnished and directions given by the said Chief Engineer, of sound, durable material, to be approved by him. The price paid shall be by the one thousand (1,000) feet, board measure, and shall be considered as in full for all material except iron, and for the labor of building and erecting complete. The iron shall be of the quality required by these specifications, and the price per pound paid shall cover all cost of material and the labor incident to its use. Spikes and nails, when used and furnished by the said Contractor, shall be paid for at cost and ten (10) per cent. added.

TUNNELS.

Approach Cut.—The approach cut shall be excavated to such width and slopes as the said Chief Engineer may direct, and the materials from the cuts and the ends of the tunnels shall be placed in embankment on the line of road adjacent, or wasted, as the said Chief Engineer may direct, and they

shall be classified and be paid for according to the Excavation Classification of these specifications.

Dimensions of Tunnels—Excavation—Cross-Section.—Tunnels shall be of such width and height as the said Chief Engineer may direct, and shall be excavated in conformity with the cross-section to be furnished by him. If a tunnel requires support, and timber is adopted, the area of its cross-section shall be enlarged and measured three (3) inches outside the lagging, or, if masonry is adopted, six (6) inches outside the exterior lines of the side walls and arching.

Classification and Price of Tunnel Excavations.—Materials from tunnel excavations shall be paid for by the cubic yard, or by the lineal foot, completed, in case such bid is accepted. The price paid shall cover all materials contained between the two portals, and strictly in all cases within the lines of the normal or enlarged cross-sections furnished from time to time by the said Chief Engineer, and shall include the cost of all temporary supports, such as props, scaffolding, strutting, etc., that may be necessary to secure a safe prosecution of the work in advance of the introduction of permanent supports of timbering or masonry, which temporary supports must in all cases be removed by the said contractor at his own expense after the completion of the permanent supports.

Bottoms.—The bottom shall be picked to a uniform surface, and no rocky protuberances will be allowed inside the general lines of the sections.

Drainage Ditches.—The drainage ditch through the center of the tunnel, shown on the drawing of the normal cross-section, shall be carefully excavated to its full dimensions, and in it shall be laid broken stone in such manner and of such size and form as the said Chief Engineer may direct.

Shafts—Excavation Price to Cover What?—The said Chief Engineer shall determine the number and location of shafts, the dimensions of which shall be such as he may direct. The excavation price paid for them shall be by the cubic yard, and shall cover all materials contained between the surface of the ground and the soffit of the tunnel, and within the area of the cross-section furnished by the said Chief Engineer. In case the shaft is sunk alongside the tunnel, the price paid shall cover all material between the surface of the ground and the level of the foot of the shaft. The price paid shall cover the cost of such curbing or other support as the sides of the shaft may require; also whatever materials or labor may be required for ventilation and keeping the tunnel and shafts free from water, and shall also cover all hoisting and pumping machinery.

Sumps.—The excavation of all necessary wells or sumps shall be paid for at the same price per cubic yard as shaft excavation.

Average Haul, How Estimated.—In estimating the average haul of materials from shaft excavations, the vertical lift of the materials taken out from the several shafts shall be counted as part of the haul.

Niches.—Niches or openings shall be left in the walls when, and at such points as, the Chief Engineer may direct.

Falls.—Drilling and blasting shall be conducted with all possible care, so as not to shatter the roof and sides outside the section lines. Any falls that, in the judgment of the said Chief Engineer, are attributable to the carelessness or want of proper skill or attention on the part of the said Contractor, shall be removed and disposed of at his own expense; but if by unavoidable accident or natural causes, not thus attributable, any outside rock shall become loose or shattered, it shall be removed by the said Contractor, and a just and equitable allowance shall be made by the said Chief Engineer to compensate and remunerate him for such removal, provided a claim for such removal be made by the said Contractor during the month in which a fall so occasioned shall occur.

Permanent Supports.—Should it be determined by the said Chief Engineer during the progress of the work that any tunnel or any portion of a tunnel requires permanent supports, or that the shafts require lining, timber or brick or stone masonry may be used for such supports and lining as the said Chief Engineer may direct.

Timber.—If timber is used, the said Chief Engineer shall determine its description and quality, and shall prescribe the general plan of the support, and it shall be paid for by the one thousand (1,000) ft., board measure, framed and placed in the work.

Iron Work.—All wrought and cast iron work ordered by the said Chief Engineer and used in the work shall be paid for by the pound in place.

Masonry.—When lining or arching of brick or stone masonry shall be ordered, it must be laid in the most skillful and workmanlike manner, and strictly in accordance with the plans and directions prescribed by the said Chief Engineer from time to time, to suit the necessities of the several cases as they occur.

Should it be determined to erect masonry facades at the portals of the tunnels, or to finish out above the surface any or all of the shafts with ventilators, such work shall be executed by the said Contractor in accordance with such plans and directions as may be prescribed by the said Chief Engineer for the same.

All masonry used in and about tunnels shall be classified and paid for, under the masonry classification of these specifications.

The commencement, extent, and termination of all timbering and masonry shall be determined by the said Chief Engineer, and, when so determined, such timbering or masonry, as the case may be, must progress close up with the excavation, and if necessary the excavation must be secured and protected by temporary supports, before the introduction of permanent ones.

Packing.—The vacancies behind the timber lagging or masonry walls, and above the arching, shall be filled with concrete or dry packing, as the said Chief Engineer may from time to time direct, which packing shall be classified and paid for under the masonry classification of these specifications. Dry packing shall consist of hard, durable stone, approved by the said Chief Engineer, broken to the required size to pack well, and shall be well rammed in.

Work Required before Acceptance.—Before tunnels are accepted, their whole length must be entirely cleared of debris, rubbish, and surplus materials of every kind, and the bottom dressed off truly to the grade line, and the central drain cleaned out and filled with broken stone, as directed by the said Chief Engineer.

Night Work, if Required.—All work incident to the construction of tunnels shall be carried on by two (2) shifts of ten (10) hours each, or three (3) shifts of eight (8) hours each, as the said Chief Engineer shall direct.

TIMBER.

All timber must be sound, straight-grained, and free from sap, loose or rotten knots, wind shakes, or any other defect that would impair its strength or durability. It must be sawed or hewed perfectly straight and to exact dimensions, with full corners and square edges. All framing must be done in a thoroughly workmanlike manner, and both material and workmanship shall be subject to the inspection of the said Chief Engineer, who may reject all timber not in accordance with the specification.

IRON WORK.

Wrought Iron.—Wrought iron must be of the best quality of American refined iron, tough, ductile, and capable of standing a tensile strain of fifty thousand (50,000) lb. per sq. in. before rupture, and twenty-five thousand (25,000) lb. without exceeding the limit of elasticity.

Cast Iron.—All castings must be made from good, tough pig metal, of a quality capable of bearing a weight of five hundred and fifty (550) lb. suspended in the center of a bar one (1) in. square, four and one-half (4½) ft. between supports. All manufacture must be of first-class, well-finished character. Castings must be full to dimensions, true, smooth, and sound.

Test bars of both wrought and cast iron shall be furnished by the said Contractor without cost when required by the said Chief Engineer.

GENERAL DIRECTIONS.

Duties of Contractors.—Contractors must satisfy themselves, by careful personal examination of the nature and location of the work they bid for, of the general form of the surface of the ground, and all other matters which can in any way influence their contracts; and no information upon any such matters derived from the maps, plans, profiles, drawings, or specifications, or from the Chief Engineer or his assistants, shall in any way relieve the Contractor from any risk, or from fulfilling any of the terms of this agreement.

Property on Right of Way.—Fences, buildings, timber, and wood on the right of way along the line of the road are the property of either the land owner or the Construction Company, and, if not removed by the land owner within a reasonable time, shall be cleared off by the Contractor, piled up, and preserved for the use of the Construction Company, without charge.

Damage to One Contractor through Fault of Another.—In case one portion of the work contracted to be done in accordance with these specifications is delayed through the negligence or incompetence of a contractor for some other portion of the work, whatever damage may result to, or whatever expense may be incurred by, the contractor so delayed, because of such negligence or incompetence, shall be charged to the contractor at fault, and the Chief Engineer shall decide the amount of damage or expense so to be charged.

Roads to be Opened.—Contractors having work awarded to them shall, immediately after signing their contracts, proceed to open and maintain such good and safe roads and paths for foot or horse travel along the whole line of their sections as may be directed by the Chief Engineer, and on portions of the line where there are no highways convenient for the wagoning of supplies, they must open and maintain such roads, and the Chief Engineer shall decide what extra amount, if any, they will be entitled to for this work.

Any persons having permission from the Chief Engineer shall be allowed to pass along or haul any materials required for the road over any section, such persons not interfering with or impeding the work of the Contractor.

Marks and Stakes to be Preserved.—Contractors must carefully preserve bench marks and stakes, and in case of willful or careless neglect, they shall be charged whatever the Chief Engineer shall consider an equitable amount to cover any damages arising from such negligence.

All excavations and embankments shall conform to the line and stakes set out by the Chief Engineer, and any excess of excavation or waste of material required for embankment at the mouths of cuts, due to neglect of these lines and stakes, shall not be estimated or paid for.

Grade.—The word "grade," whenever herein used, refers to the surface of the road-bed as completed and prepared for the reception of the ballast.

The specifications are hereby acknowledged, accepted, and made part of this agreement.

_____

_____

_____

Contractor.

_____

President of the American Construction Company.

_____, 188

BOND.

Know all men by these presents, that we are held and firmly bound unto the American Construction Company, in the sum of Thousand Dollars, to be paid to the said American Construction Company, its successors and assigns, for which payment well and truly to be made we bind ourselves, our heirs, executors, and administrators, jointly and severally, firmly by these presents. Sealed with our seals and dated this day of A. D. 188

Whereas,

ha entered into an agreement with the American Construction Company for the execution of the grading on Section No. of the Division of the South Pennsylvania Railroad, bearing date the day of A. D. 188

Now, the condition of this obligation is such that if the said shall well and truly keep and perform all the terms and conditions of the said agreement on part to be kept and performed, and shall indemnify and save harmless the said American Construction Company as therein stipulated, then this obligation shall be of no effect, but otherwise it shall remain in full force and effect.

WITNESSES:

_____ _____ [L.S.]

_____ _____ [L.S.]

_____ _____ [L.S.]

State of _____ } ss.:

of _____ }

County of _____ }

On this day of 188 , before me personally appeared to me known to be the person described in and who executed the foregoing bond, and acknowledged that executed the same.

EARLY AMERICAN RAILWAYS.

MR. JAMES B. EADS has written a new book entitled "Notes taken in Sixty Years." Here is a chapter on the early history of American railways:

It is no wonder that little was known of railroads or locomotives in our quiet region along the Juniata sixty years ago. It was only in 1823 that the act of Parliament for the Stockton & Darlington Railroad, in England, was passed—a road projected by the Quaker Edward Pease, and laid out by George Stephenson—the first railroad in the world for general commercial purposes, and opened for traffic in 1825. In that year the civil engineers were preparing to invade our Juniata Valley, and the Stockton & Darlington Railway began a revolution in the habits of the human race, which is already more wonderful than any other on record.

The first railroads in the United States were built to carry gravel, stone, anthracite coal, and other heavy materials. All were short. One was built on Beacon Hill in Boston, in 1807; one in Delaware County, Pennsylvania, in 1809; and one at Bear Creek Furnace, Armstrong County, Pa., in 1818. The tracks were composed of wooden rails. Other short roads, similarly constructed, were built in various places. Prior to 1809, Oliver Evans, of Philadelphia, urged repeatedly in public addresses the construction of a passenger railroad from Philadelphia to New York, and in that year attempted to form a company for this purpose. In 1812 Colonel John Stevens, of Hoboken, New Jersey, published a pamphlet recommending the building of a passenger railroad from Albany to Lake Erie, but his suggestions were not heeded.

In April, 1823, the State of New York chartered the Delaware & Hudson Canal Company to construct a canal and railroad from the coal fields in Pennsylvania to the Hudson River at Rondout; the railroad, 16 miles long, from Honesdale to Carbondale, to carry coal, was completed in 1829. In 1826, the Quincy Railroad in Massachusetts, four miles long, was built to haul granite to the port of Neponset; the rails were of wood, strapped with iron. In 1827, the Mauch Chunk Railroad, nine miles long, was built in Pennsylvania to connect coal mines with the Lehigh River; the gauge was three feet seven inches, and the wooden rails were faced with iron. In 1826, the State of New York chartered the Mohawk & Hudson Railroad, for freight and passengers, from Albany to Schenectady, 17 miles; work was not begun till 1830, and the road was opened for travel in September, 1831.

On February 28, 1827, the State of Maryland chartered the Baltimore & Ohio Railroad. Work was begun July 4, 1828, and in 1829 the track was finished six miles, and "cars were put upon it for the accommodation of the officers, and to gratify the curious by a ride." This was the first road in the United States that was opened for the conveyance of passengers; it was finished to Ellicott's Mills, 13 miles, in 1830. The Washington branch was opened to Bladensburg in July, and to Washington in August, 1834.

The Charleston & Hamburg Railroad, in South Carolina, was chartered in December, 1827. A locomotive was placed on it in 1830. The road was completed in September, 1833, a distance of 135 miles. At that time it was the longest continuous line of railroad in the world. The rails used on the Charleston and on the Albany road were of wood, with flat bar-iron nailed on them. The track of the Baltimore & Ohio consisted of cedar cross-pieces and string-pieces of yellow pine 12 to 24 feet long and six inches square, with iron bars on them. The flanges of the wheels were on the *outside*. After some miles of this kind of road had been made, long granite slabs were substituted for the cedar cross-pieces and pine stringers. "Iron strips were laid for miles and miles on stone curbs." Before the road had been finished to Point of Rocks, in 1832, "wrought iron rails of the English mode" had been laid on part of the line.

About this time various patterns of rolled iron rails were in use in England. The first of these was the fish-bellied, invented and patented in 1820, and which fitted into cast-iron chairs. The larger part of the Stockton & Darlington road, 37 miles long, was laid with rolled rails of this pattern, weighing 28 pounds to the yard. On the Liverpool & Manchester road "the rails used were made of forged iron, in lengths of 15 feet, and weighed 175 pounds each."

The Clarence rail was an English improvement; it rested on chairs, but did not have the fish belly, its upper and lower surfaces being parallel. These rails were used on the Allegheny Portage road, in Pennsylvania, finished in 1833. On a part of the Philadelphia & Columbia road, opened in 1834, flat rails were laid either on granite blocks or wooden string pieces, but the larger part of the track had Clarence rails. On the Boston and Lowell road, completed in 1835, stone cross-ties were at first laid, some of which were in use as late as 1852. On one track of this road the H rail was laid; this rail rested on chairs and had a web similar to that of the T rail.

Many years elapsed after the first railroad was built before any other than flat rails were made in America. All the heavy rails were imported from England. Up to 1843 there were no facilities for the manufacture of heavy iron rails to supply the wants of the 4,185 miles of American railroad existing at the beginning of 1844, and of a few hundred additional miles then projected. The first heavy rails were rolled in 1844, of the U pattern, at the Mount Savage Iron Works in Maryland. The first T rails made in America were rolled at the Montour Mill at Danville, Pa., in 1845.

The T rail, now universally used on American railroads, is generally supposed to be of English origin; but it was invented by Robert L. Stevens, of Hoboken, N. J., in 1830, and was first laid on the Camden & Amboy Railroad. It did not come into general use until after 1845. The first made of these rails were only 16 feet in length. The first rails 30 feet in length were made at the Cambria Iron Works at Johnstown, Pa., in 1856, but there being no demand for them they were used on the tracks of that company at their works. The first 30-foot rails rolled on order were made at the Montour Works in 1859. The first 60-foot or double-length rails were rolled at the Edgar Thomson Steel Works, Pennsylvania, in 1875; and that company in 1876 exhibited a steel rail at the Centennial Exhibition 120 feet in length, weighing 62 pounds to the yard. The rail mills in the United States have now a capacity of 3,000,000 tons of iron and steel rails per annum. More than nine-tenths of the rails rolled in 1882 were of steel.

The first locomotive, the "Stourbridge Lion," did not touch American soil until I was 12 years old. At a convivial meeting in 1855 Major Horatio Allen, engineer of the Erie Railroad, described in a speech the first trip made by a locomotive on this continent:

"Where was it? And who awakened its energies and directed its movements? It was in the year 1829, on the banks of the Lackawaxen, at the commencement of the railroad connecting the canal of the Delaware & Hudson

Company with their coal mines, and he who addresses you was the only person on that locomotive. The road had been built in the summer, the structure was of hemlock timber, of large dimensions, notched in caps placed far apart. The timber had cracked and warped from exposure to the sun. After about 300 feet of straight line the road crossed the Lackawaxen Creek on trestle work about 30 feet high, with a curve of from 350 to 400 feet radius. The impression was very general that this iron monster would either break down the road or leave the track at the curve and plunge into the creek. My reply was that it was too late to consider the probability of such occurrences; there was no other course but to have a trial of the strange animal, which had been brought here [from England] at great expense; but that it was not necessary that more than one should be involved in its fate; that I would take the first ride alone, and the time would come when I should look back to the incident with the greatest interest. As I placed my hand on the throttle-valve I was undecided whether I would move slowly or with a fair degree of speed, but believing that the road would prove safe, and preferring if we did go down to go handsomely, and without any evidence of timidity, I started with considerable velocity, passed the curve over the creek safely, and was soon out of hearing of the cheers of the vast assemblage. At the end of two or three miles I reversed the valve and returned without accident to the place of starting, having thus made the first railroad trip by locomotive in the Western hemisphere."

Pioneer of wonders, good Major Allen! Unconscious of the great future; for if I had told thee, then, that in 54 years there would be more than 110,000 miles of railroad in the United States, and 250,000 in the world, derision would have curled thy shaven lip!

As late as 1829, two distinguished engineers, Mr. Walker and Mr. Rastrick, solemnly advised the use of stationary engines, instead of locomotives, on the Liverpool & Manchester Railroad, then nearly completed; but Stephenson insisted on the locomotive, and at a competitive trial in October, 1829 (for a prize of £500), the "Rocket" ran at the rate of 25 miles an hour, and settled the question. In 1830 the road was opened with locomotives.

Peter Cooper built the first locomotive made in America, the "Tom Thumb," and ran it on the Baltimore & Ohio road in August, 1830. It was a small affair, rather a working model than an engine for service, and Mr. Cooper was his own engineer. To make a tubular boiler he used gun barrels. "The Best Friend of Charleston," the first American locomotive for actual service, was built at the West Point foundry in New York city, and put to use on the Charleston & Hamburg Railroad in South Carolina, in 1831.

The idea of hauling cars by horses was not given up for some years after the first railroads were constructed in the United States. I think horses or mules were used for a time on the Pennsylvania State road from Philadelphia to Columbia. On most of the levels of the Allegheny Portage Railroad the cars were drawn by horses. In 1837, when I first saw it, this road had but one locomotive.

Another old-time idea was that railroads should be used like common roads, and every citizen be at liberty to put on his own cars, just as he could put his wagon on a turnpike road, and pay tolls. Very crude and absurd it all seems now; but the Pennsylvania State road, from Philadelphia to Columbia, was for a number of years operated simply as a highway for vehicles of transportation owned by individuals. The "Commonwealth" furnished the track and all motive power, but the cars were private property, and tolls were paid for the use of the track and hauling the cars. Laughable enough, now, is it not? But it was a very serious matter then, especially as the "superintendent of motive power" was a State officer, and belonging of course to the political party in power, was always charged by the party not in power with stealing all he could. In course of time the cars came to be owned by companies, and individual owners disappeared; but I have forgotten at what time the State undertook to provide both cars and engines, and to charge freight on the goods instead of tolls for the use of track and hauling. Years ago the road passed from the ownership of the State to that of the Pennsylvania Railroad Company. A prolific source of partisan corruption was closed up, but the interests of party contests fell off badly. Patriotism waned as profit fled.

As our first railroads had, generally, only the "flat rail"—bars of iron spiked on stringers of wood or stone—they were very imperfect, but were a great deal better than none; and I feel no shame to confess that we were very proud of them. No great speed was made or expected. Accidents were not unknown; but there was one peril which we escape on the T rail. Sometimes the end of a flat rail would turn upward, pierce the car bottom, disturb the passengers, and be decidedly unpleasant, if it did not destroy life or limb, or throw the car from the track. These intruding rail-ends were called "snakeheads."

The cars first in use were small affairs. The "burden cars," as the freight cars were called 45 years ago, were boxes, a little longer than their width, and had a wheel at each corner. Three or four tons made a load for one of them. Cars and engines have been in course of improvement ever since the first were put on the track; but the locomotive, with all its varied improvements, and its greater weight and power, is in essentials—steam blast, tubular boiler, and connecting rods—the same as when George Stephenson's "Rocket," in September, 1830, ran 30 miles an hour on the Liverpool & Manchester Railroad, astonished the Duke of Wellington, and killed Mr. Huskisson.

There were no telegraphs for a number of years after railroads were in use; but the managers nevertheless ran their trains, and we got along. The world can do without a great many things it has never enjoyed. I do not remember what the speed was on our railroads in early days, but probably about 15 miles per hour as a maximum for passenger trains. On the Baltimore & Ohio branch to Washington in 1841 and 1842 (when I had not yet risen above political life), we sometimes made 20 miles per hour, passing a mile post every three minutes by the watch; but I think this was above the average, and was a special blessing vouchsafed to the office-seekers, enabling the expectants to reach the capital quickly, and the disappointed to get home before their borrowed money had all run out.

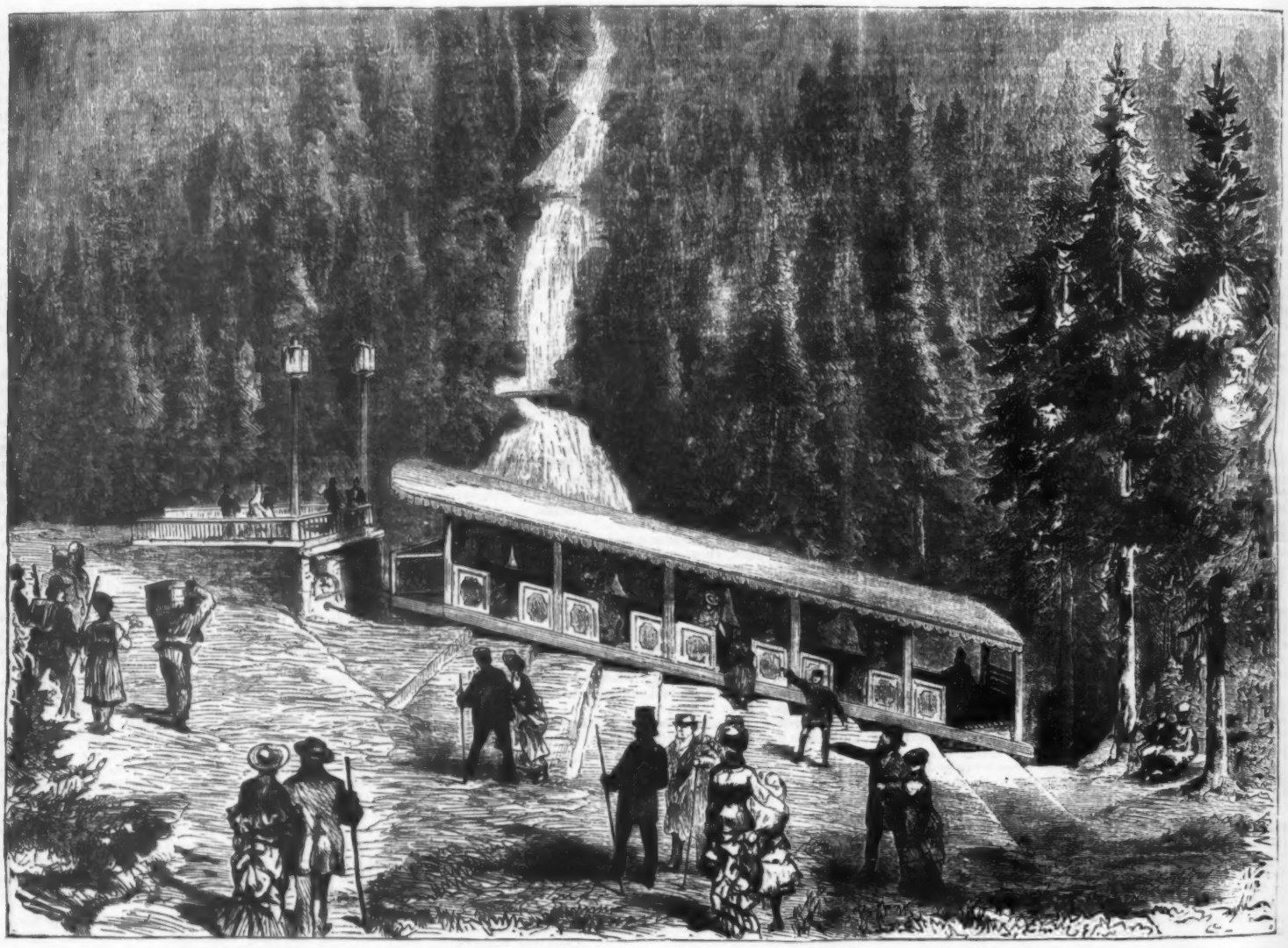
The telegraph, tried and enjoyed in 1844 as a curiosity between Washington and Baltimore, was opened for general business April 1, 1845. But I need not here write of the telegraph, or more of our magnificent railway system; if fully described this year, their extension and expansion would require a supplementary description next. When Napoleon's army was marching past the pyramids, he said to his soldiers, in immortal bombast, "Forty centuries look down upon you!" I never knew what he meant. I hardly think the dead centuries look down on anybody. But let them look at our railroads—if they can.

THE CABLE RAILWAY AT THE GIESSBACH IN SWITZERLAND.

THE Giessbach, near Brienz, is well known as one of the most beautiful points of interest in Switzerland, and is visited by thousands who cross the beautiful lake at Briens. Lately a cable railway has been built, which carries the visitors from the station at the lake to the hotels at the head of the falls and back for one franc. The grade is one to four; the track is one meter wide and forms one continuous straight line from the lake through the beautiful woods to the plateau on which the hotels are built.

The railway has but one track with the exception of the switch part. Between the tracks a cogged rail is provided in the same manner as in the Rigi railway, but this rail does not serve to propel the cars; it is merely a safe-guard, as it prevents derailment, and serves as a brake by engaging with a cog-wheel in the middle of the car, which cog-wheel is connected with a brake-wheel in such a manner that by applying the brake the car can be stopped instantly. The cars resemble the open cars of street railways, but are longer, and divided into six compartments which together contain forty-six seats. The floor is arranged horizontally and consists of a number of steps. The sides are open, but are provided with hinged doors which can be closed to prevent people from falling out. At the upper station of the railway a large reservoir is provided which can hold four tons of water, the water being conducted into the said reservoir from the Giessbach. When the car arrives at the upper station the conductor couples the car to the reservoir, and admits a quantity of water into a suitable compartment in the car. The water weights the car sufficiently to enable it to draw up the empty car at the bottom, so that each car alternately serves as a motor, that is, it is filled at the upper end station, runs down the plane and draws up the empty car, and at the lower end station the water is permitted to run out of the compartment in the car.

The cost of running is, naturally, reduced materially, as no motor is required, and the Giessbach furnishes a more than abundant supply of water to run the road in the manner described above.—*Illustrirte Zeitung.*

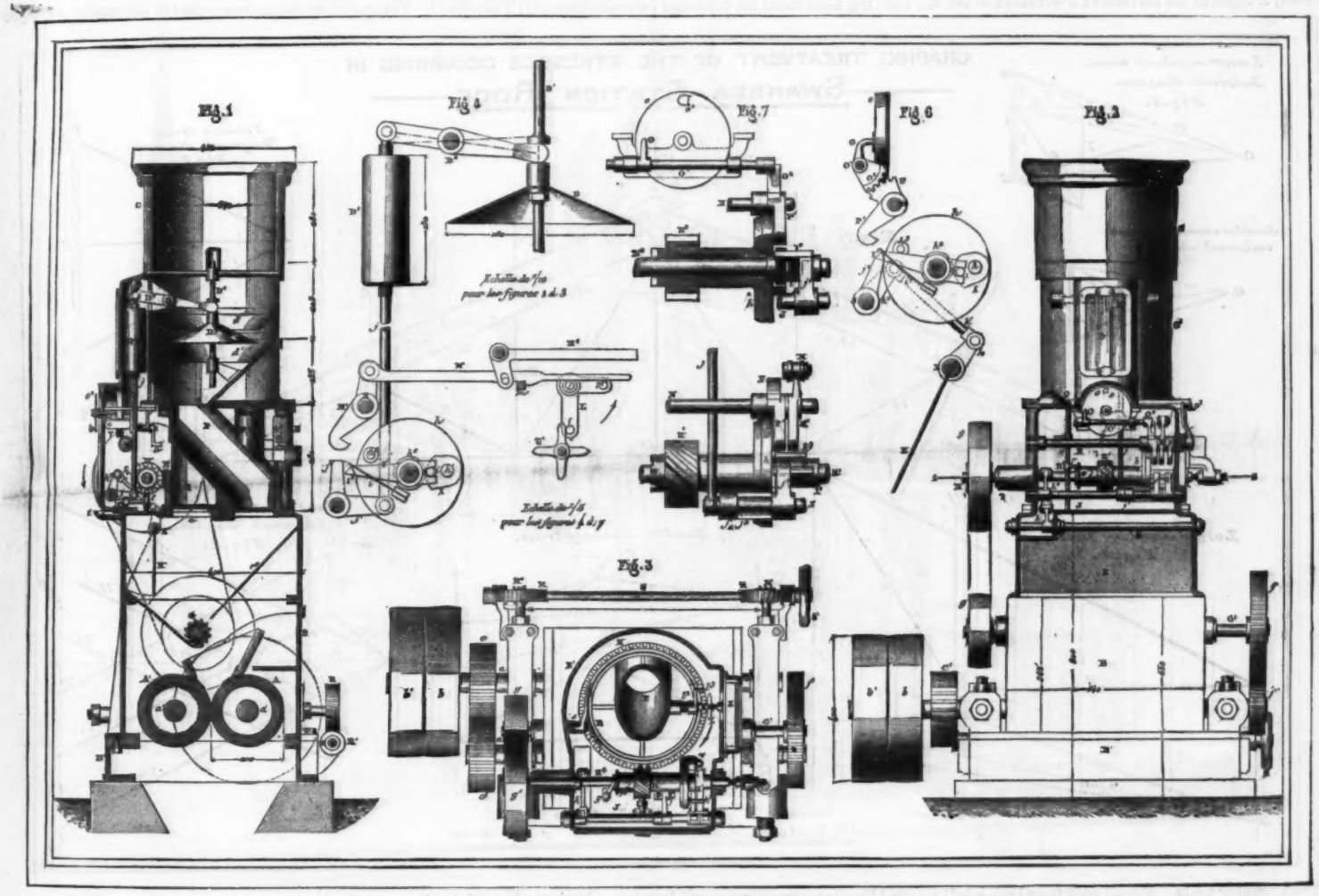


THE MOUNTAIN CABLE RAILWAY AT THE GIESSBACH, SWITZERLAND.

MILL FOR CRUSHING MALT.

THE chief interest of this apparatus centers in the ingenious combinations that have been devised to secure an exact account of the material that has been submitted to its action, such precautions having been suggested by the mode of collection, in Germany, of the tax on beer, this being based upon the quantity of malt treated in each brewery.

In the apparatus under consideration, the malt, before reaching the crushing cylinders, is carefully measured by intermittent charges which are registered by a counter. But, to prevent all error, the part that measures the charges, as also the counter, must stop as soon as any irregularity



IMPROVED MILL FOR CRUSHING MALT AND OTHER SUBSTANCES.

manifests itself in the discharge, either when the material arrives in too small a quantity to fill the measurer or the work of the crushing cylinders is insufficient to treat the quantities of malt that the measurer furnishes them. The manufacturers of this remarkable machine make several sizes of it. In the one shown in the accompanying engraving the volume of the measurer, and consequently of each charge, is 5 liters.

Fig. 1 of this engraving shows the mill in vertical section perpendicular to the axis of the cylinders. Fig. 2 gives an elevation perpendicular to the preceding, and partially in section, and shows the mechanism in general of the starting gear. Fig. 3 is a horizontal section made on the line 1-2. The following figures, 4 to 7, represent the same gears separately and on a larger scale:

The essential members of the mill itself are two cast iron cylinders, A A', that revolve within a box, B, resting upon a base, B'. Upon the axis, *a*, of one of these cylinders are mounted the fast and loose pulleys, *b b'*, through which the apparatus receives its motion. The cylinders are driven by the two like wheels, *c* and *c'*. The cylinder, A, is capable of being brought more or less close to A', and, to this end, revolves in movable pillow-blocks.

The box that contains the cylinders serves as a base to that part of the apparatus which contains all the pieces that constitute the different mechanisms employed to secure the exact measurement of the quantities of material that are submitted to the cylinders, and that are poured into the wooden hopper, C, at the upper part. This hopper is mounted upon a cylinder, C', in whose interior is placed a sheet iron funnel, *d*, which directs the malt upon a distributing cone, D. This latter is mounted in such a way as to preserve the position shown in Fig. 1 only as long as the fall of the malt holds it there, while, if the supply stops, it rises and, in this evolution, brings about a stoppage of the counter. Under the cone, D, there is a second funnel, *d'*, which secures the directing of the malt upon the measurer, E, which occupies the compartment, E'. This important part consists of a drum of cast iron capable of revolving around its axis, and which is cast in a piece with an inclined hollow cylinder, F, whose two extremities open freely at the ends of the drum, E.

The bottom of the compartment, C', contains an aperture, *e*, of the same dimensions as the orifice of the measurer. In the bottom of the box or case, B, there is likewise a similar aperture, *e'*, placed upon the same vertical line as the preceding. The result is that at the moment the upper orifice of the measurer coincides, by virtue of its motion, with the aperture, *e*, the malt that falls from the upper part enters the measurer, F, and fills it, but cannot descend into the box, B, since at the same moment the lower orifice of the measurer corresponds with an entire part of the bottom of the box. But by virtue of this same rotary motion it is, on the contrary, the lower orifice that afterward corresponds with the orifice, *e'*, while the upper orifice is hidden by the entire part of the bottom of C'. Then, no malt can any longer run into the measurer, while the entire contents of the latter are, on the contrary, free to run into the box, B, and to fall upon the cylinders, A and A'. The material, under these circumstances, is directed by a hopper, e^2, whose lower orifice is provided with a channeled feed cylinder, G, fixed upon an axis, G', that is provided, in order to actuate it, with a spur wheel, *f*, gearing with a pinion, *f'*, fixed upon the axis, *a'*, of one of the cylinders.

From what precedes, it will be seen that the cylinders are fed by *intermittent charges*, and that each of these latter, whose amount is known, corresponds with a full measure, F, and with every revolution of the drum, E. It is not difficult to see that this number of revolutions and, consequently, the number of charges in a given time may be exactly noted by means of an ordinary counter, X, which indicates, in fact, the product in hectoliters.

The Measuring Drum.—Aside from the figures generally, Figs. 4, 5, and 7 show in detail the pieces that make up this important mechanism. The drum, E, is provided with a gear crown wheel, H, having helicoidal teeth and engaging with a pinion, H', which is mounted loosely upon a shaft, H^2, that is actuated by a shaft, G', by means of a belt and of the two pulleys, *g* and *g'*. The pinion, H', is connected with a long sleeve that terminates in a disk, *h*, upon which is mounted freely through the intermedium of a stud, *h'*, a cam, I (Figs. 3, 4, and 6). The active part of this is an eccentric which is in contact with a shoulder on the shaft, H^2. According to the position taken by the cam, it presses strongly upon the shoulder, h^2, or is slightly removed from it. In the first case, its action on this shoulder renders the sleeve and pinion, H', and the shaft, H^2, interdependent, so that the measurer is made to revolve. In the second case the pinion, H', remains loose, and the drum remains motionless. The movement of the cam, I, whence results the throwing of the pinion, H', into or out of gear, is effected through the intermedium of a sort of click, I', which is placed against the disk, *h*, and is forged with a socket mounted loose upon the shaft, H^2, whose click is then entirely independent.

This click has a shorter and forked branch which hugs a stud, *i*, fixed in the cam, while the other branch is submitted to the action of a spring, *i'*, which is fixed upon the disk, *h*, and which, as long as nothing prevents it, tends constantly to revolve the click in the direction in which, through its position, and which is mounted upon an axle, K'. This latter likewise carries a lever, *k*, which is connected by a rod, *k'*, with another lever, k^2, keyed to the shaft, J. Finally this latter, which we have already seen acting as a simple support, is provided at its opposite end (Fig. 2) with a tappet lever, k^3, designed to produce upon the click precisely the same effect as in the preceding case.

When the discharge of malt is normal, and it falls regularly upon the crushing cylinders, the hopper, e^2, is relatively empty, and the plate, K, preserves its position. If the contrary happens, and the discharge becomes less than the supply, the hopper fills up and the plate, K, is shoved to the left, and in its motion causes the tappet, k^3, to act upon the click, I', and to thus again stop the measurer.

Ungearing of the Measurer when the Counter makes a Resistance to its Motion.—(Figs. 3, 4, and 6.) The counter, X, is actuated by the measurer and by the vertical arm of a lever, L, which is mounted upon a rod, *l*, inserted into one of the ribs of the body, E. This lever arm carries a stud, *l'*, which at every revolution of the measurer meets one of the radii of a wheel, L', which is fixed upon the first axle of the counter, and gives it a quarter-revolution (Fig. 3). But the lever and its rod, *l*, are materially dependent only through the action of a spring, l^2 (Fig. 3), which thrusts it against a neighboring rib, and which, through the resulting friction, gives it sufficient resistance to act upon the wheel, L', without oscillating upon its rod.

If through any disarrangement of the counter, the wheel, L', makes an unexpected resistance, the lever, L, causing its spring to yield before it, will oscillate in the direction shown by the arrow (Fig. 4).

The horizontal arm of the lever is likewise provided with a stud, l^3, immediately above which is situated the extremity of a bar, M, coupled with one of the arms of a lever, M'. This latter, which is mounted freely upon another axis, N, has on its lower arm a hook which, during its motion, arrests the click, I', when the lever, M^1, is effecting the proper oscillation.

Now, the bar, M, is usually held by a stop, *m*, which prevents it from sliding to the right or left under the action of the lever, M^2, that is attached to it, and whose horizontal arm constitutes a counterpoise capable of producing such an effect. But if the bar, M, be raised by the lever, L, oscillating upon its rod, *l*, it will escape from the stop, *m*, the weighty lever, M^2, will carry it to the left (Fig. 4), and the lever, M', in oscillating, will stop the click, *i'*, by means of its hook, and the result is that the motion of the measurer will again be suspended.

Ungearing of the Measurer when a Given Quantity of Material has passed through the Crushers.—(Figs. 1, 2, 6, and 7.) The apparatus is also provided with a means of ascertaining with certainty when a given number of hectoliters of malt, fixed upon in advance, has been crushed, so that the measurer can be stopped as soon as the operation is finished.

For this purpose there is employed another counter, Y. The piece that operates this latter is a sort of winch, *n* (Fig. 1), which meets at every revolution a stud, n^1, projecting from the drum, E. This piece is dependent upon a mechanism that ends at a graduated disk, *o*, which thus undergoes a slow rotary motion, and serves as an indicator for the quantity of malt to be passed into the apparatus. Now, this disk presents at one point on its surface a notch, o^1, into which penetrates at certain times the bent extremity of a lever O (Figs. 6 and 7). This latter is keyed upon an axle, O^1, that also carries a toothed segment, O^2, which engages with a like segment, P, that is mounted loose on the axle,

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N. This latter segment forms part of a lever and catch, P^1, whose action upon the click, P, is the same as has already been described.

So long as the end of the lever, O, bears against the unperforated part of the disk, o, nothing occurs; but, as soon as the notch presents itself, this lever, carried along by the weight of the lever, PP^1, enters it, and the hook, P^1, arrests the click, P, and consequently the measurer. This mechanism is arranged so as to operate with different quantities of material. It will be remarked that the axis of the disk, o, carries a needle, o^2, which moves in front of a dial that indicates the number of hectoliters. Were it desired, for example, to arrange the apparatus for a total passage of 20 hectoliters, the needle would be carried to that figure. Then, the operation of the counter being based upon that starting point, the notch would perform the angular motion required to reach the lever, O, at the very moment that the 20 hectoliters had traversed the mill.

Ungearing the Measurer by Hand. (Figs. 2 and 3.)—The motion of the measurer may be arrested by hand in a very simple manner. The axle, N, which is merely a support for the pieces, M^1, and PP^1, carries, keyed with it, a lever and hook, p, and an external winch, p^1. As this lever is arranged so as to act upon the click, P, in the same way as the preceding ones, it is easy to see that the same effect will be produced by manipulating the axle, N, by means of the winch. The measurer may thus be thrown into or out of gear at will. When a stoppage has been caused by a failure in the supply, or by a stopping up of the lower hopper, the starting at once takes place automatically as soon as the cause of the trouble is removed. When, on the contrary, a stoppage occurs because the proper amount of malt has been treated, or in consequence of the counter getting out of order, it requires the services of a workman to set the machine running again. For all such functions, a bell is provided to make known the stoppage, this being especially necessary when the stoppage is absolute and the measurer is unable to start again of itself. This bell (Figs. 2 and 3) consists of a gong, Q, and a rod, q, which carries the hammer, and is surrounded by a spiral spring that holds the hammer constantly against the bell. This axis carries also a lever, r, which the spring holds in contact with a sleeve, r^1, which is fixed upon the shaft, H^2, and which gears with the driving pinion, H^1, through an escapement. When the pinion is in gear and is revolving with the shaft, the sleeve, r, forms part of the latter, and the meshed teeth do not separate; but, as soon as the pinion becomes stationary, and while the shaft continues to revolve, the teeth become disengaged, the sleeve slides upon the shaft, and, under the influence of the spring, effects a series of rapid entrances and exits that the hammer repeats by striking upon the gong.

The Measuring Drum.—The measurer, F, properly so called, is provided with a means of having its capacity accurately regulated. This is a solid cylinder, F^1 (Fig. 1), which is capable of rising or descending by virtue of its being mounted upon a threaded rod that may be made to enter more or less deeply into the space, F, so as to regulate the internal volume to the desired amount. The drum, E, is also provided with a ratchet, s (Fig. 3), which is mounted upon the crown-wheel, H, and is connected with a click, s^1, whose purpose is to prevent the measurer from turning backward.

Lubrication of the Driving Pinion, H^1. (Fig. 1.)—This pinion engages, so to speak, with a felt disk, t, in the center of which ends a wick that dips into an oil cup, t, opening externally. Thus is prevented all escape of oil that might reach the malt.

Regulation of the Cylinders.—This is effected in the same way as is usual in like cases. The bearings of the shaft, a^1, are attached to two screws, u, upon which are mounted helicoidal wheels, R, which gear with endless screws, R^1, fixed upon the shaft, S. It is only necessary, then, to maneuver the shaft through its hand-wheel, S^1, in order to simultaneously move the bearings of the shaft, a^1, and thus regulate the distance of the cylinders, A and A^1.

All the internal compartments of the apparatus are reached by means of doors that may be opened at will.—*Publication Industrielle.*

GRAPHIC TREATMENT OF STRESSES IN FRAMEWORKS.

By ROBERT HUDSON GRAHAM, C.E.

THERE can be little doubt that civil engineers prefer graphic to analytic methods of calculation, not only because they are more rapid and elegant, but also because they obviate the danger of those serious arithmetical blunders which so frequently occur in long and tedious analytical processes. On this account we may anticipate that ere long the graphic methods of treating stresses in frameworks—first applied by Taylor, and afterward largely developed by Clerk Maxwell, Culmann, Cremona, Fleeming Jenkin, and Levy—will gradually supersede the older analytic methods, except in a few cases where analysis becomes inevitable. The examples worked out in this series depend on principles already expounded by other authors, as well as on some developments of the subject, which have occurred to the writer during a long period of research in this field of science, and which are embodied in a work now going through the press. Here the theory of the subject will only be so far introduced as is necessary to explain the construction of the reciprocal diagrams of stress. In geometrical phraseology, two triangles are said to be similar when their lines are respectively parallel or perpendicular to each other; and in graphic statics, two figures are said to be reciprocal when the lines composing them fulfill the following two conditions: (1) That their lines are respectively parallel or perpendicular to each other; (2) that lines radiating from a point in one figure are parallel or perpendicular to corresponding lines, forming in the other a closed polygon. All figures fulfilling simultaneously the preceding two conditions will be termed reciprocal. For example, Figs. 1 and 2 are in the fullest sense of the term reciprocal, insomuch that any line 18, Fig. 2, is drawn parallel to the corresponding line 18, Fig. 1; and moreover, any lines 4, 15, 16, 18, 19 converging to a point in Fig. 1, form a closed polygon 4, 19, 18, 16, 15, in Fig. 2. Under these conditions, the length and direction of lines in Fig. 2 furnish the stresses produced by the given system of loads in the bars correspondingly numbered in Fig. 1. Thus line 18, Fig. 2, measured off the annexed decimal scale of tons, determines the amount of tension induced in bar 18, Fig. 1. Similarly line 10, measured off the same scale, furnishes the amount of compression in member 10, Fig. 1.

(2) *Swansea Station roof.*—The roof structure, Fig. 1, has been treated according to two distinct methods. First, the roof is divided into its component trusses, A E A^1, A D C E A, and A B C, and the graphic sum of the component stresses is then taken, in order to find the resultant stresses in each bar. This may be called the method of summation. Next, the roof is treated as a whole, and the resultant stresses found in one operation, by aid of the general reciprocal diagram, Fig. 2. The two methods mutually check each other.

The primary truss.—The truss A E A^1 is called the primary truss; and, when isolated, is considered to bear half the whole weight on the roof: that is to say, half the weight on each side rafter is supposed to be concentrated at the ridge, and half at the lower point of support A or A^1. Hence, one half the whole weight on the two side rafters is taken to be concentrated at the ridge, producing thrusts along the rafters proportionate to this special distribution of the loads. The reciprocal figure of the primary truss, A E A^1, is given in Fig. 3, where A B represents the half weight upon the truss, or, A B=$\frac{1}{2}$ of 13 tons=6½ tons. The heavy line 15 represents the thrust induced along E A; and the line 19 that along E A^1. The light line 17 furnishes the component tension in tie-rod, A A^1, due to the separate loading of the primary truss.

The larger secondary truss.—One of the larger secondary trusses, A D C E A, Fig. 1, is shown separately in Fig. 4; and Fig. 5 is the corresponding reciprocal figure. The independent loading of this truss can be found by supposing a load to be concentrated at D, Fig. 1, equal to the sum of half the load between A and D, and half that between E and D; or in all, to half the load distributed over the side rafter, which is 6½ tons. The reciprocal figure 5 shows that the stress along bar 7 or 14, due to the separate loading of the larger secondary truss, is compressive and equal in amount to the load of 3¼ tons concentrated at D. The component compressive stress in bar 15, Fig. 1, or bar 5, Fig. 4, due to the loading of the same truss, is represented by the dark line 5, Fig. 5; that in bar 13 or 4 by the line 4, Fig. 5; the tension in bar 16 or 6 by line 6, and the component tension in member 11 or 8 of the tie-rod by the unshaded line 8, Fig. 5. All these lines must be measured off the given decimal scale of tons. The upward reaction at the ridge, arising from the independent loading of the larger secondary truss, is shown on Fig. 5 by the double line, B C, and is equal to 2¼ tons; the other reaction at the point of support, A, is represented by the double line, C D, equal to 1 ton on the given decimal scale. The amounts of these reactions, as well as the points, C, Figs. 3, 5, and 7, are determined by the usual graphic method of polar or funicular polygons, constructed relatively to different poles, O, as shown on the figures. For instance, the triangle in dotted lines 1^1 2^1 3^1, Fig. 4, is the polar or funicular polygon reciprocal of lines converging from the points B C D to the pole, O, Fig. 5.

The smaller secondary truss.—One of the smaller secondary trusses is shown separately in Fig. 6, of which Fig. 7 is the corresponding reciprocal figure. The independent loading of this truss is found by supposing a load to be concentrated at B—Fig. 1—equal to the sum of half the weight between B and A and B and D, or, in all, to half of 4½ tons. The reciprocal diagram, 7, gives the stresses in the members of the smaller truss separately loaded. The dark line, 5—Fig. 7—represents the thrust along bar 12 or 5; the line 4 the thrust in bar 10 or 4; and the light line 6 the component tension in member 11 or 6 of the great tie-rod A A^1. The tensional reaction along bar 14 is represented by the double line B C or 2—Fig. 7—and is equal to 1¼ tons, and the reaction at A, by the double line C D, equal to 1 ton.

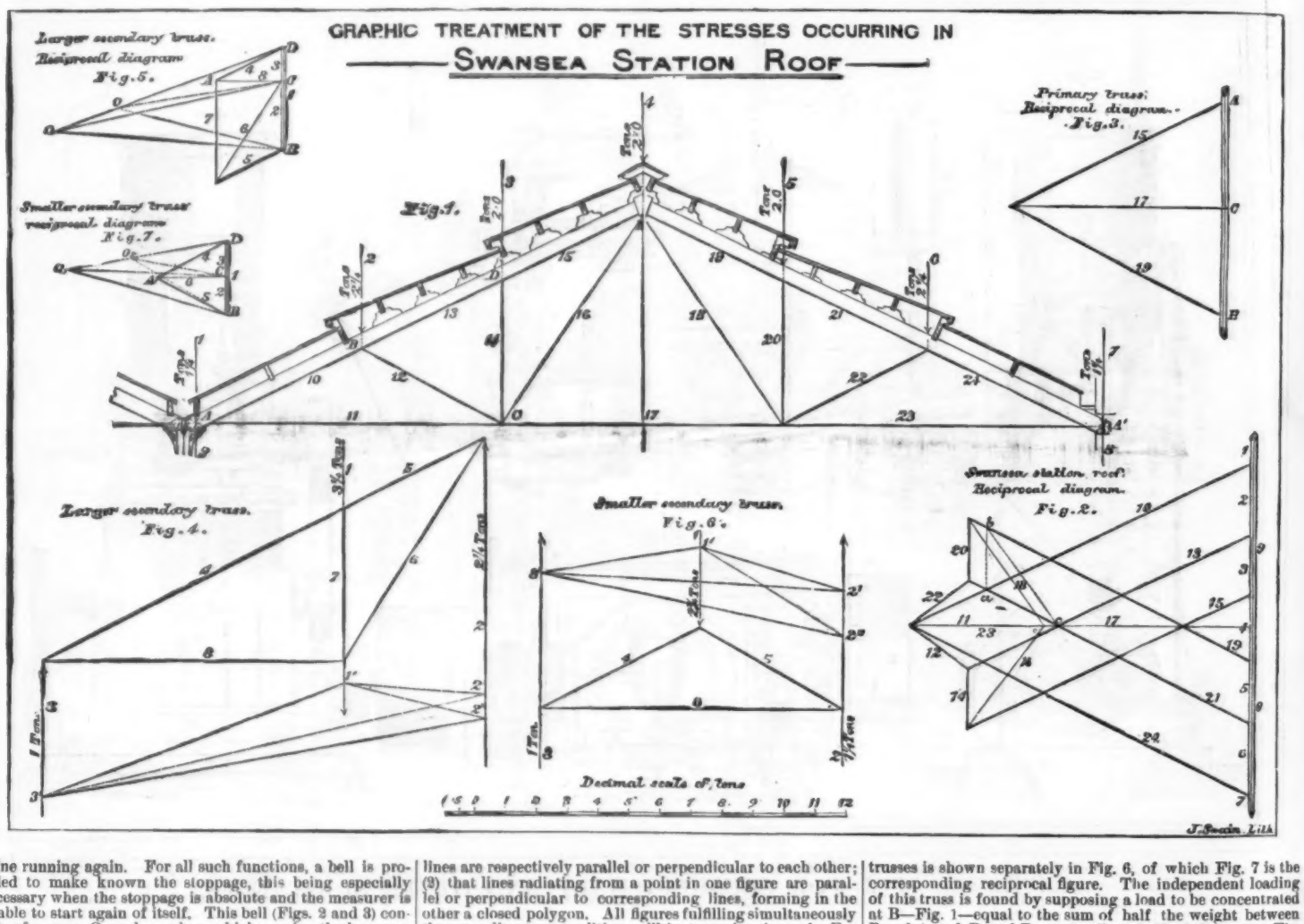
General reciprocal figure.—Fig. 2 is the general reciprocal diagram of the roof structure, taken as a whole, and forms a check upon the method of division into separate trusses and summation of component stresses previously developed. The component stresses found by the truss process are cumulative, that is to say, the resultant stress in any bar is equal to the sum of the component stresses belonging to the several trusses, of which the bar forms a part. Thus, the resultant stress in bar 15, which forms part both of the primary and larger secondary trusses, will be represented by the sum—

Resultant thrust, 15=line 15 (Fig. 3)+line 5 (Fig. 5)
=7¾ tons+2$\frac{5}{16}$ tons
=9$\frac{1}{16}$ tons=line 15 (Fig. 2).

Again—
Resultant thrust, 14=line 7 (Fig. 5)—line 2 (Fig. 7)
=3¾ tons—1¼ tons
=2 tons=line 14 (Fig. 2).

Thirdly—
Resultant tension, 11=line 17 (Fig. 3)+line 8 (Fig. 5)+line 6 (Fig. 7)
=6¼ tons+2$\frac{5}{16}$ tons+2$\frac{1}{16}$ tons
=10$\frac{6}{16}$ tons=line 11 (Fig. 2).

These values, taken from a larger drawing, can be verified


GRAPHIC TREATMENT OF THE STRESSES OCCURRING IN
SWANSEA STATION ROOF
Larger secondary truss. Reciprocal diagram Fig.5.
Smaller secondary truss reciprocal diagram Fig.7.
Fig.1.
Primary truss: Reciprocal diagram. Fig.3.
Larger secondary truss. Fig.4.
Smaller secondary truss. Fig.6.
Swansea station roof. Reciprocal diagram. Fig.2.
Decimal scale of Tons
J. Swain Lith.

within small fractional differences, on the reduced drawings which accompany this paper.

It will be seen that bar 16 forms part of only one independent truss, A D C E A, and therefore lines 6, Fig. 5, and 16, Fig. 2, ought to be strictly equal. The same is true of lines 5, Fig. 7, and 12, Fig. 2. The end-triangular truss of each side rafter is non-symmetrical; that is to say, the bar, A B, is longer than B C. Had they been made equal, the reciprocal diagram, Fig. 2, would have undergone slight modifications, indicated by the dotted lines, *a b c*, where the stress, *a b*, that is, 14 or 20, remains unchanged, the tension, 18, is shortened to *b c*; while, on the other hand, the thrust in bar 22 would be slightly increased. On the whole, this roof furnishes a very compact reciprocal figure, and evinces care and beauty of design; the only fault we have to find lies in the overhang in the ledges of the covering, which seems to afford a leverage to wind pressures. On the other hand, it may be urged that they contribute to good ventilation, and quick discharge of rain and snow.—*The Engineer.*

THE NEW TOWN HALL, WESTMINSTER.

WE give an illustration of the new Town Hall, Westminster, London, which was opened on the 19th of July last. The style adopted, both for the principal external elevations and the internal decorations and finishings, is Renaissance. The elevations facing Caxton street (late Little Chapel street) and Palmer's street (late Gardener's lane) are built of red brick facings in gauged work, with dressings of red Corsehill stone, consisting of richly moulded stringcourses, cornices, pilasters, etc., to bay and other windows, and gables; the principal entrance doorway and panels to the windows being richly carved in foliage and arabesque. The panels to the windows are further enriched with medallion portraits of eminent men, who have been more or less connected with Westminster—viz., Milton, Chaucer, Shakespeare, Tyndale, Newton, Locke, Bacon, and Caxton. In the keystone of the arch over the front doorway is a figure representing "Security," "Confidence," and "Trust," and in the spandrel panels are figures with the cornucopia, representing "Plenty;" on the pedestals at either side are sculptured figures of St. Margaret and St. John; over these, in niches, are sculptured figures of her Majesty the Queen and H.R.H. the Prince of Wales; over these again are busts representing "Fame" and "Abundance."

The centre gable rises to a height of 65 feet from the ground level, and is covered with a curved Mansard roof, finished with ornamental lead-work and iron cresting. On either side of the entrance doorway, at the extreme ends, are bay windows, the cants being circular and with rich gables; these are also covered with Mansard roofs, about 55 feet high, and, like the center Mansard, finished with ornamental lead-work and iron cresting; all these roofs and also those portions between the Mansards are covered with green slates; there is also a turret roof, octagonal on plan, and rising to a height of about 60 feet over the side entrance; the chimney stacks are built of red Corsehill stone.

The whole of the windows in the front and return end are glazed with tinted cathedral glass in small squares, the lower portions being of clear glass. This portion of the building has a basement, consisting of rooms for the resident caretaker, a strong room, lavatories, etc., etc.; on the ground floor are the entrance vestibule, and, to the right and left, offices for the vestry clerk, rate collectors, and other officers, waiting room, etc., the public staircase built of stone, and the staircase hall. The staircase in this hall, intended for the use of the members of the united vestries only, is constructed of wainscot of an ornamental design, supported on paneled and carved newels and brackets; this part is covered with a lantern light, and roof of oak with moulded timbers, divided into panels about 4 feet square, filled in with stained glass of an elaborate scroll design.

There is also a side window filled in with stained glass, the subjects in which are the arms of the High Stewards of Westminster—as Lord Burleigh, James Duke of Ormond, Earl of Arran, Earl of Lincoln, Thomas Duke of Newcastle, Marquis of Buckingham, Viscount Sidmouth, and Duke of Buccleugh—under these being the arms of the city of Westminster, and of the Westminster Collegiate School. The front entrance doors are of teak with stained glass; the swing doors leading to the staircase hall are also of teak, with panels of embossed plate glass. On the first floor are a reading room, a room for the reception of deputations, two sub-committee rooms, and a large committee room, 33 feet by 23 feet, the ceiling and walls of which are richly ornamented. On the second floor and the third floor, over the principal entrance, are rooms for various purposes connected with the affairs of the two vestries.

Descending now to the ground floor, and passing through the staircase hall before mentioned, there are wide corridors, leading to offices for the surveyor to the district board of works, the surveyor's clerks, sanitary inspector, etc. Above these, and leading from the public staircase, and the oak private staircase before mentioned, is the board room, entered by wainscot oak doorways, with fluted columns, carved caps, moulded cornice, and pediment—a fine room 55 ft. by 40 ft. 6 in. and 25 ft. high. The floor of this hall is laid with oak parquet, wax polished; the ceiling is formed into panels with pitchpine moulded ribs; the ceiling and walls are richly decorated, the colors being all of subdued tints, harmonizing with the light reflected from the stained glass windows. There is a public gallery at the south end, the whole of the front being of walnut, supported by iron stanchions, cased with walnut formed into fluted columns, moulded and carved bases and capitals, the front above these being formed of turned moulded balusters and moulded capping. At the north end is a handsome chimneypiece, also of walnut, containing sculptured figures in niches on either side, representing "Faith" and "Hope" and in the center of the frieze, foliage and a group representing "Charity." Above the shelf is an over-mantel, consisting of fluted pilasters with carved capitals, surrounded by a moulded and carved cornice and pediment, the whole inclosing a brass memorial tablet. There are also two doorways at this end of the room, leading to a private gallery in the public hall. On the east and west sides are large windows, each in three divisions, filled with stained glass, the subjects chosen being historically connected with Westminster. They are as follows:

I. First Parliament at Westminster; Simon de Montfort enforcing the rights of the people on Henry III. at Westminster.
II. Caxton explaining his printing press to Edward IV. and his Queen in Westminster Abbey.
III. The Architect of Westminster Abbey explaining his plans to Edward.
IV. Elizabeth Woodville, Queen of Edward IV., seeking sanctuary at Westminster.
V. Coronation of Queen Victoria at Westminster Abbey.
VI. Sir Francis Burdett proposing a measure of Parliamentary Reform, June 9, 1809.

On the south side over the public gallery is also a stained glass window of nine lights, containing the following emblems in the form of medallions set in wreaths; they are, "Truth," "Knowledge," "Concord," "Fortitude," "Prudence," "Justice," "Industry," "Frugality," and in the center light the arms of the Duke of Westminster, each subject being surrounded by elaborate and richly painted ornament, the principal color used being a creamy white, treated in black and gold.

Leaving the board room by the oak staircase, and passing along the corrider northward, before mentioned, we enter the public hall, 80 ft. by 41 ft. and 40 ft. high, one end of which is circular on plan, and having a platform at the opposite end. The windows at the sides are glazed in tinted and white cathedral glass; the large window over the platform is of stained glass, the subjects chosen for this being "Science," "Commerce," and "Art," exemplified by scenes taken from Shakespeare, as from the "Tempest" for Science, "Prospero revealing his power over the World of Spirits;" from the "Merchant of Venice" for Commerce, the Rialto at Venice, "Shylock at the Notary's," and "Antonio receiving the ducats," and from "Timon of Athens" (act i., scene 1), for Art. There is a gallery round the two sides and the circular end constructed of wainscot, and supported on iron cantilevers, over each of which is a paneled die or pilaster with moulded capping, the spaces between the dies being filled in with turned moulded balusters; the floor of this hall is of pitch pine, polished; the ceiling is formed into panels by pitchpine moulded ribs, a large cove being formed all round. There has been very little attempt at decorating either the walls or ceiling; in the choice of the colors the object is gained of giving a cheerful appearance.

The public entrance to this hall is from Palmer's Street, and provision is made in case of panic for nine modes of exit from the floor of the hall and three from the gallery, all the doors opening outward. Provision is also made in case of fire in this as in other portions of the building, by a fire main and hydrants, with all necessary hoses, buckets, etc. The halls, staircase, committee room, and corridors are warmed by hot water. The arrangement for lighting the public hall is by gas from three sunlights from the ceiling, and wall brackets under the gallery. The board room and the large committee room are each lighted by two similar sunlights and wall brackets; around the public hall are retiring rooms and w. c. The architects of the building are Messrs. Lee and Smith.—*Building News.*

NEW WESTMINSTER TOWN HALL.

ELECTRICAL TRACTION.

SOME weeks since experiments were made in Paris by the French Electrical Power Storage Company on tram-car propulsion by means of electricity.

M. Philippart has addressed a communication on this topic to a member of the directing committee of the Compagnie Générale des Omnibus, the subject of which is published in our French contemporary, *L'Electricité*, and given in the *Electrical Review*. M. Philippart says in his letter, dated Paris, July 8, 1883:

"You have congratulated me on the success of our traction experiments on tram-cars driven by electricity; and you have stated that this success seemed complete. But, like every one else, you have asked me the question, 'What is the cost?' With regard to this question I give you the figures which will allow you to form your own opinion.

"We performed the journey from the Place de la Nation to the Place de l'Etoile by the outer boulevards for the fifth time last Thursday. Although the car was loaded (its total weight, everything included, was at least ten tons), although the grooves of the rails were filled with dust collected by the sweepers, and notwithstanding slopes from two to five centimeters, the journey was completed in one hour. The indications of the galvanometers and voltameters showed that we expended during the whole of the journey, all allowances made, a force equal to 10 electrical H.P. (1 electrical H.P. = 750 volt-amperes). We therefore utilized, during one hour, an electrical H.P. per ton, to make a journey of 10 kilometers with a machine which rendered a coefficient of 70 per cent. of useful work.

"By means of these indications any engineer can calculate at what point the conditions were unfavorable, nevertheless it is upon an effort equal to an electrical H.P. per ton drawn that we shall establish our calculations. For everything I shall take the actual maxima, leaving to the future all improvements and reductions. We shall estimate the loss of electricity in charging and discharging the accumulators at 25 per cent., although Profs. Thompson, Ayrton, and Morton have only proved 20, 18, and even 10 per cent. loss.

"Lastly, we shall reckon that a ton of accumulators can give only 30 electrical H.P., while our experiments gave 40.

"Upon all these premises there can be no dispute, their verification being possible at any time in our workshops.

"It only remains, therefore, to establish the cost price of the accumulators, the dynamo-machines, their maintenance, and their durability.

"The dynamo will cost 2,500 fr. for an effective power of 12 to 15 H.P. Its maintenance consists in the replacing of the brushes and the wearing of the bearings. The principal expense, therefore, is the price and maintenance of the accumulators; and this is, without doubt, the principal object of your inquiry.

"Here again I shall allow a good margin. Besides the price of the royalty and of the box which contains the lead, this metal, which constitutes the accumulator, costs, manufactured in plates suitable for the requirements of traction, 600 fr. per ton (we have an agreement at this price). The worn out plates are replaced at 350 fr. per ton.

"You know as I do that, in an accumulator, the duration of the negative plate is almost unlimited; the positive plate alone, after a duration of 4 to 12 months, becomes unfit for use, because all the lead is peroxidized and is no longer conductive. Without doubt, sooner or later, a remedy will be found for this defect; meanwhile, let us put things at the worst, and say that three times per year, or every four months, we shall change the positive plates, that is to say, half the weight of the accumulators.

"We have, therefore, to reckon 1½ tons per ton and per year, at 600 fr. per ton, that makes 900 fr., from which we have to deduct 1½ tons at 250 fr. = 375 fr. This leaves an annual expenditure of 525 fr. per ton, let us say 600 fr. with the manipulation.

"You have now all the figures and all the elements necessary for ascertaining the cost price per day and per car. Allow me to assist you by explaining how I think that our processes ought to be applied to obtain the best possible results.

"And first of all I shall take care not to touch your cars at all in placing our machines and our accumulators, as we have done, on the experimental car. I shall replace the horses by a truck 2 meters wide by 4 meters long, occupying just the same space as the horses; above the wheels a space 75 centimeters high will contain the machine and the accumulators, and upon the whole will be fixed an elegant covered compartment to accommodate 12 passengers paying 50 centimes for all distances. This compartment will certainly bring in 50 fr. per day.

"Let us see now what we shall have to expend in capital first of all, then the cost of working and dividends.

"For each car in use we shall require two trucks, each capable of working for 5 hours, or of traveling 60 kilometers without being recharged.

"Your own cars for 50 passengers, fully loaded, weigh 7 tons, the trucks will weigh 8 tons:

Axles and framework	2½	tons.
Accumulators and machines	4½	"
Passengers	1	"
Total	8	"

Of which 3 tons is accumulators.

"As we have 15 tons to draw, we require a force of 15 electrical H.P.; or, for 5 hours, 75 H.P. hour. We have seen above that 1 ton of accumulators would render 30 H.P. hour; with 3 tons we shall have, therefore 90 H.P. hour, or a reserve of 15 H.P. hour. You see that I give you the promised good measure.

"Each truck will cost 10,000 fr., all complete; it is therefore an expenditure of 20,000 fr. per car in use, that is to say, exactly what your horses and harness cost at present. There will remain this advantage, half the depots at least may be suppressed, less the expenditure for the installation of fixed machines for charging the accumulators, which will not exceed 5,000 fr. per car in use.

"We now come to the cost of working, which we divide into 3 portions:

"1st. The motive power.

"2d. The interest and paying off the capital employed.

"3d. The maintenance of the accumulators.

"For each journey of the car, we require 150 electrical H.P. hour, or 200 H.P. hour, in consequence of the loss of 25 per cent. allowed above.

"I need not point out to you that for carbon, oil, manipulation, maintenance, and paying off a H.P. hour, produced on a large scale, does not cost 5 centimes.

"At this price the traction will cost 10 fr. per day. I add 5 fr. for oil, grease, and maintenance of the dynamo and trucks; this is, in all, 15 for the motive power.

"We have then the interest and paying off of a capital of 25,000 fr. per car in use: let us reckon 12 per cent. or 3,000 fr. per year and per car.

"Lastly, six tons of accumulators at 600 fr. for the maintenance, that makes 3,600 fr. per year and per car. We will add to these two last figures 700 fr. per year and per car for general expenses, that will make, in round numbers, 20 fr. per day.

"You see that although I have raised my figures, I have only 35 fr. per day; and, as my conductor will bring me back at least 50 fr., I can still take 15 fr. per day and draw your car for nothing.

"But this is not the only benefit which I bring you.

"The extra 30 kilometers traveled!

"The possibility of increasing, at certain hours and on certain days, the certain number of cars in use.

"And the possible creation of special cars making during the first and last hours of the day a service at reduced prices for carrying workmen.

"I hope I have answered your question in a satisfactory manner. I publish this without fear of the criticism of engineers, electricians, and any competent persons. I am persuaded that all will say that my figures are exaggerated, and that they leave for the future a vast field for improvement of every kind. We shall speak later on of the traction of road-cars."

ELECTRICITY IN COAL MINES.

AT the recent meeting of the Institution of Mechanical Engineers at Liege, an interesting paper on the application of electricity to the working of coal mines, by Mr. Alan Bagot, of London, was read, of which we give an abstract.

The author divided his subject into two heads, as follows: 1. The application of electricity to signaling purposes; 2. The more recent application of powerful electric currents for the purpose of illumination, or of transmission or storage of power, both on the surface and within the workings of the mine itself. He began by explaining the defects of the old system. In 1874 he determined on using electricity for signaling purposes, and from thence to 1877 he carried on a series of experiments in different shafts with a view to determine whether insulated cables, naked copper wire, stranded copper or iron wire, or galvanized iron telegraph wire was the most suitable conductor for conveying the current in the shafts. The result of trials in several different districts showed that insulated cables were too expensive in the first instance, and also were practically useless, being stripped and destroyed by falling coal from the cages, etc., and especially liable to electrical leakage. What was still worse, they were subject to a form of back charge, due, no doubt, to the coating of coal dust which adhered to the sheath of the cable. Further, their position did not allow of their being readily tested or inspected, and unnecessary delay took place in finding disconnections and other electrical faults, when the cable was not manifestly disturbed or injured.

Stranded iron wire was found too prone to rust, and of too high an electrical resistance; stranded copper wire too heavy; solid copper wire too soft and too apt to draw. No. 11 galvanized iron telegraph wire, 0·120 in., was too light, and of too high a resistance for either shafts or engine planes. Finally, No. 4, 0·238 in. galvanized iron telegraph wire, was found most suited for shaft conductors, and No. 8, 0·165 in., for engine planes. The shaft conductors were hung vertically from shackles on the pit frame to the bottom of the shaft, without any intermediate support, the depth in some cases being 600 to 700 yards. The conductors were provided with wooden blocks on each side of the wire, screwed tightly together with thumb-screws, to act as safety clips, and to prevent the wire from falling down the shaft in the event of an overwind or explosion carrying away the shackles on the pit frame. To the lower end of each wire, which hung free in the sump, was attached a 20 lb. weight to act as a compensator. Harris' Deep Navigation Colliery at Quaker's Yard was thus fitted in 1880, the depth of the south pit to the four-foot Aberdare seam being 695 yards. The arrangement of No. 8 wire for the engine plane signals at Risca, North Dunraven, and other collieries, was practically the same as an ordinary overhead telegraph line.

The batteries found most suitable were twelve-cell large-size Leclanche batteries; the outsides and the insides of the glass cells down to the level of the exciting fluid were well brushed with paraffine oil to prevent efflorescence and evaporation. The evil effect of coal dust in the pit batteries was avoided by pouring a little common engine oil on the surface of the exciting fluid, thus sealing it from the air of the mine. Great advantage was derived in wet shafts, where the electric leakage was great, by duplicating the pit batteries for quantity, and thus keeping the tension low.

The author then described in detail the system of signaling employed at Cannock and Rugeley collieries. The electrical transmission of special orders is effected by two dial circuits previously mentioned; the current being supplied from the batteries required for the bell service. The transmitters are simply circuit closers, provided with mechanical means for insuring an electrical contact of given duration; and by means of an air piston, provision is made that the apparatus cannot be left in such a position that the circuit remains closed. In practice twelve separate orders may be transmitted in ten seconds. Latterly, however, in the present year, with a view to leaving the banksman and cager at liberty, it has been found desirable to substitute clockwork transmitters in place of the step-by-step transmitters. In these new instruments the natural operation would be for the clockwork to run itself down. This is prevented by a revolving projecting pin coming in contact with the pin of a lever corresponding to the zero point on the signal, and denoting "safety." For example, on pushing back No. 0 lever, and pulling out No. 5 lever, the clockwork revolves, makes five separate contacts, transmits five electric currents of given duration, and actuates the receiving apparatus five times; the corresponding order, namely, "men coming up," being simultaneously indicated on all the dials in the circuit. The revolving projecting pin of No. 5 lever then arrests the clockwork until the transmission of the next signal, before which No. 5 lever must be pushed back. In engine plane signals, the bell signals are made at any part of the road, by simply making connection between the line and the return wire, and thus closing the circuit; this can be done by the boy in charge of the journey, while the tubs are running.

Another application of electricity in coal mines is the electric recording anemometer introduced by the writer. There is another application of electricity which has been found extremely useful by the writer. It is desirable at times to hear the action of pump valves in the pit, without having to send the sinkers down. For this purpose the writer has used with success a modified telephone, attaching it to the outside of the valve cover; but to get really exact repetitions of the beat of the valves, a stout piece of asbestos card should be interposed between the valve cover and the mouth of the telephone. A little practice enables the engine man to follow the action of the valves as accurately as when, in the human body, the heart's action is examined by means of the stethoscope.

The author next considered the application of electricity in mining for illumination and for transmission or storage of power. In 1881 the writer experimented at length on the illumination of the pit bank and screens at Harris' Navigation collieries. A Gramme dynamo machine was driven off an engine that worked a Schiele fan, thus insuring great steadiness of motion and economy in motive power. The result of the experiment showed that incandescent lamps were useless, and powerful arc lamps, fixed 40 ft. above the ground, the most suited for the purpose. Of all types of dynamo machines, the Edison low tension machine is most suited, in the writer's opinion, for colliery purposes; while the Brockie, Serrin, or Crompton arc lamps are suitable, if an arc is required for illumination, in connection with a Gramme or Siemens dynamo. At the Risca collieries the electric light is introduced into the pit from a dynamo machine driven at the surface. The cable is taken down the shaft, and connected with a series of Crompton incandescent lamps of large size at the bottom. These give an excellent light, and facilitate very greatly the work of the cagers and the men in the gate-roads. But as regards the introduction of such lights into coal mines, for the purpose of illuminating the working stalls and faces, the writer wishes to draw attention to the 7th general rule, section 76, Mines Regulation Act, 1872, which provides that "In every working approaching any place where there is likely to be an accumulation of explosive gas, no light or lamp other than a locked safety lamp shall be allowed or used." It must be borne in mind that with safety lamps a constant watch is kept on the appearance of gas. Now a blower of gas has been known by the writer to back up against an air current of 65,000 cubic feet per minute passing down the split; and with electric lamps no notice would be given of the fact. Such accidents—or again, a fall of roof breaking a wire, or the breakage of a lamp—cannot be guarded against; and hence the writer is of opinion that no increased safety would be afforded by the electric illumination of the working faces from dynamo machines. It must be borne in mind that a miner, when holing, requires his safety lamp just above or below his work, and is constantly shifting its position and his own, as the holing progresses, to set sprags. This would be a serious difficulty; and further, before withdrawing his sprags to allow the coal to come down, he would have to move the incandescent lamp away altogether and refix it afterward. Allowing ten minutes for the two operations, this, in a mine of sixty working stalls, would entail a loss of ten hours per day, say one man's labor, or 3s. 6d. daily.

Except in long-wall work, reflected illumination by means of electricity would be impracticable. In effect, therefore, without going into details of cost at the present time, electricity can only be successfully applied to the illumination of the working faces by means of a hermetically sealed glass incandescent lamp containing a supply of electricity for nine hours' consumption. If this is charged from dynamo machines at the surface, due regard must be had to the length of time occupied in the operation. The weight of each electric lamp should not exceed that of the present lamps in use, or 3 lb. as a maximum. Such an appliance does not at present exist. The useful application of electricity for the transmission of power would be confined to underground haulage, on the electrical tramway principle of Sir William Siemens and others. But, according to the writer's information, such engines as those constructed at the Grange Ironworks, Durham, or compressed air locomotives, are capable of being used far more economically than electricity, so that the question of electric haulage need not be considered.

Recapitulating the points mentioned, the writer advocates the use of electricity for the purposes of signaling and illumination, as regards the pit bank and pit bottom; but cannot at present approve its adoption for the transmission of power in the workings, or for illumination at the working faces. He is of opinion that no increased safety would be thereby derived, and that inconvenience and danger might arise through falls of roof; while the constant watch upon gas, kept by the present extensive use of self-extinguishing lamps, would be removed. Lastly, in the writer's opinion, the 7th general rule of the Mines Regulation Act, 1872, would not be complied with in such cases.

The discussion was opened by M. Tresca, who speaking in French, considered at some length the causes of loss of useful effect in electrical transmission, referring to the experiments of Marcel Deprez, but adding nothing to the information already possessed by electricians. Mr. Cochrane referred to the admirable lighting of the Channel Tunnel borings by incandescent lamps, and said, further, that he saw with astonishment that they wound coal in Belgium, even at the rate of 600 yards a minute, while the man in charge of the engine could not see the pit's mouth, but trusted entirely to dial indications. A short note from Mr. Killingworth Hedges was then read by the secretary. Mr. Hedges briefly described a new miner's lamp invented by him, in which the incandescent lamp floats on water, inside the glass, so that the moment the glass is broken the water runs out and the current is cut off.

THE MANUFACTURE OF ENCAUSTIC TILES.

THE highly decorated pavements of the medieval ages, principally to be found in old ecclesiastical structures, which often shared the fate of many beautiful details of architectural ornament by being made to give way to what church officers and others of equal taste and discernment deemed improvements after attracting the attention of the antiquary for centuries, have at length excited some interest among the practical minds of these stirring business times. Above thirty years ago a patent was obtained by S. Wright, of the Staffordshire Potteries, in England, for the revival of this interesting branch of art, for such it may be truly called. As might have been expected, many difficulties beset the patentee, and for some years nothing was produced equal to the old specimens. But still a beginning was made that promised success, when skill and capital, and a determination to succeed, should be brought to bear upon the subject. And these were not long wanting, as the patent ultimately passed into the hands of a gentleman undeterred by difficulties or previous failures, and who expressed his intention to make encaustic tiles, such as would secure the public approbation, even if each one cost him a guinea. The gentleman referred to is Herbert Minton, who, with untiring industry, collected the best specimens of

old tiles that could be found in the country, and by a succession of experiments overcame the obstacles that had retarded the success of his undertaking.

The chief of these obstacles was to discover clays of different colors that could be made to amalgamate in such a way as to contract or shrink equally during the process of drying and firing; and until this object was effected, a perfect tile of several colors could not be produced, sundry unsightly cracks appearing on the inlaid parts of the surface. It will be unnecessary to speak of the present state of perfection to which these beautiful tiles have been brought, further than to observe that they are yearly becoming more appreciated, both on the score of durability and ornament; and there can scarcely be a doubt that, very soon, no ecclesiastical building, having any pretensions to architectural superiority, will be considered to be complete in its decorations without them. Not only are copies of old tiles manufactured, but every variety of design suitable for the character of the building they are intended for are supplied. Almost any pattern can be produced with facility, and in many instances they have been adopted as a substitute for oil cloth in the halls and passages of mansions, being considered far more beautiful, and, from their durability, more economical also, in the long run.

At Minton & Co.'s works the following is the mode of manufacture: The clays of which the tile are made are obtained in the immediate neighborhood—the ordinary marl producing a good buff color when fired; another kind a warm red; black is produced by staining with manganese; blue with cobalt, etc. With the native clays there is a slight admixture of Cornwall stone and clay, and flint from Kent, etc. The whole are subjected to a variety of washings and purifications—the clay intended for the surface especially—and passed through fine lawn sieves in a liquid or "slip" state, as it is technically termed. In this state it is conveyed to the slip kiln, or rather pumped in it, and boiled until it is in a plastic state, and fit for use.

After the modeler has done his part, the pattern is cast in plaster in relief, and is then placed in a metal frame of the size required; but it should be stated that to produce the ordinary six-inch square tile it is modeled 6⅝ inches, to allow for shrinkage or contraction, which takes place during drying and firing. The maker then commences his operations. A piece of fire clay for the surface is flattened out to about a quarter of an inch thick, somewhat after the manner of preparing a pie crust, and this is thrown upon and pressed upon the plaster pattern, and receives, of course, a correct indentation or outline of the design. The metal frame containing the plaster mould is divided horizontally, and after the surface is put in the upper part of the frame is screwed on, and the maker fills up with clay of a somewhat coarser description, to form the tile of the requisite thickness. The tile is then put under a screw press to impart the proper degree of solidity.

As far as we have gone, the tile is but of one color; next comes the task of giving the different colors required. Suppose a tile be required of three different colors—red, blue, and buff. We will say the surface piece already put in is of a buff color. The maker provides himself with vessels of a suitable kind, containing—the one the blue, the other the red color, in a "slip" state, and these he pours into those parts of the indented surface that the drawing or finished tile before him tells him to be correct. These slips cover the surface entirely, and there is now not the slightest appearance of any pattern or design. After remaining in this state for three days, until the water has evaporated for the most part, the process of scraping or planing the surface commences, which is an operation requiring care, though easily effected by experienced hands. The pattern then makes its appearance, but the colors are scarcely distinguishable the one from the other.

The tile is then finished as far as the maker is concerned; and, after remaining in the drying house from 14 to 21 days, according to circumstances, is conveyed to the oven, where it is exposed to an intense degree of heat for about 60 hours. After being drawn from the oven, the tile is finished, except it be that the parties ordering wish the surface glazed, a rapid and easy process, the dipper merely placing the surface in a tub of glaze.

Plain self-colored tiles, such as black, red, chocolate, buff, etc., and also tesseræ, are made of the same material as the encaustic, only that it is dried longer in the kiln, passed through rollers to reduce it to a powder, and is then finely sifted. Presses of great power, made under Prosser's patent, make these tiles. The powdered clay is swept into a recess of the proper size, the screw descends, and by its immense power presses the powder into a solid tile ready for drying and firing. One man can, with ease, make about 500 a day.

Tesseræ are now extensively used for mosaic pavements, for which they are admirably adapted. The mosaic pavements of the Romans were formed of small pieces of stone or marble of various colors, bedded one by one in a layer of cement, each of the pieces being leveled with the others as the work proceeded; and on the completion of the work the unavoidable inequalities of surface were corrected by rubbing the whole to a plain surface.

This mode of proceeding was attended with many defects. The irregular shapes of the tesseræ caused the cement joints to be of a thickness that greatly injured the effect of the design, while the piecemeal way in which the work was laid rendered it very difficult to produce a level surface.

These difficulties have been entirely overcome by the use of the patent tesseræ, which, being made in steel dies, by the process above described, are perfectly uniform in size, and fit closely together, with an almost imperceptible joint.

The mode in which the tesseræ are used is precisely the reverse of the Roman process, and is as follows: A colored design of the intended mosaic having been drawn to a scale, the pattern is set out full size on a cement floor, perfectly smooth and level, and on this floor the tesseræ are placed close together, the workmen being guided in the arrangement of the colors by the small drawing. The pieces are then joined together by a layer of cement applied to the upper surface, and in this way they are formed into slabs of convenient size, which, when hard, are ready for use, and can be laid with as much ease as ordinary flagstones. It will at once be understood that the side of the slabs which is next the floor during the process of manufacture forms the upper side of the finished pavement, the pattern appearing reversed during the operation.—*Glassware Reporter.*

THERE was received recently at the Smithsonian Institute five feet of the butt of a white oak tree, five inches in diameter a foot from the ground, through the center of which a pine board one inch thick and twelve inches wide had been driven several feet by the recent cyclone in Mississippi. Nothing could more forcibly show the terrible effect of the wind.

ISOCHROMATIC PHOTOGRAPHY.

PHOTOGRAPHY, despite the great strides that it has made, has, in a certain respect, remained stationary at the point at which Daguerre left it. Silver salts acted upon by light are very easily reduced by the most refractive rays of the spectrum, while they are scarcely influenced by vibrations of great wave-length; so that the blue violet end has been designated as the chemical region of the solar spectrum, and the red extremity as the calorific region.

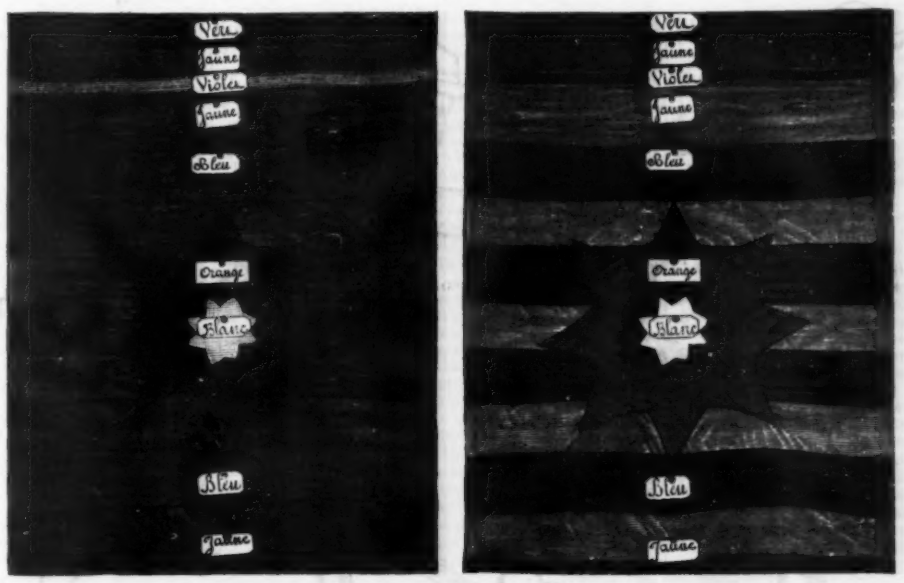
The result is that when a photographer wishes to represent blue-colored objects, even very dark, such objects come out white or clear gray. Inversely, objects of an orange or yellow color, even very bright, appear of a very dark tint. Hence a true interversion of shades that causes despair among painters whose pictures are reproduced by the photographer. A lady dressed in a straw-yellow robe, and seated in a blue arm-chair, appears in the photograph in a nearly black robe, and in a nearly white chair.

The same difficulties arise in the presence of nature. A lemon comes out much darker than a greengage plum; the blondest hairs are black; blue eyes are absolutely white; and freckles form black dots.

Photographers have for some years occupied themselves with these changes in color, which necessitate delicate retouchings that can only very rarely and but partially remedy the evil. Waterhouse first, then Cros and Ducos du Hauron, found a means of obtaining a reproduction of the true shades, either by passing the light through colored media, or by impregnating the collodion with eosine. But their results did not appear to be satisfactory enough to interest the photographic craft in them. Moreover, gelatino-bromide processes have now absolutely dethroned collodion.

Two Parisian photographers, Messrs. Attout-Tailfer and Clayton, have succeeded in giving to gelatino-bromide, with eosine, the property that Waterhouse gave to collodion. The plates prepared by them give a reproduction of the shades just as would be done by a draughtsman with his pencil. Yellow comes out bright, blue appears dark, and orange gives an intermediate shade.

The engravings which we reproduce from proofs shown by these gentlemen to the Photographic Society represent stripes that are alternately dark blue and bright yellow, with an orange star. The best commercial gelatino-bromide plates bring out these so different tones in a tint that is nearly uniform; but, on the contrary, those made by Messrs. Tailfer & Clayton at once clearly set off the differences between them.



Photographic reproductions of a fabric striped alternately dark blue and bright yellow, and with an orange-colored star.
FIG. 1.—By ordinary gelatino bromide plates. FIG. 2.—By Messrs. Tailfer & Clayton's new plates.

It may readily be seen what applications can be made of this valuable process in the reproduction of pictures and of fabrics of different colors, and in the photographing of portraits, animals, flowers, landscapes, and in scientific researches where it is necessary to reproduce red or yellow objects.

We shall not dwell upon the great interest that lies in this improvement. It is only necessary to remark in conclusion that these plates, that the inventors call *isochromatic*, cost the same, can be printed from as quickly, and are used in exactly the same way as ordinary gelatino-bromide ones.—*La Nature.*

SEPARATIONS OF GALLIUM.

By M. LECOQ DE BOISBAUDRAN.

Separation from Tellurium.—The liquid containing tellurium in the state of tellurous acid is mixed in the cold with a sufficiency of hydrochloric acid and saturated in the cold with sulphureted hydrogen. Tellurium sulphide is precipitated, while the gallium is found in the filtrate, which is not, however, always absolutely free from tellurium. In an accurate analysis the clear liquid should therefore be boiled for some minutes, while a current of hydrogen sulphide is passed through it, and the slight traces of tellurium sulphide obtained by this second operation are collected on a filter. When the volume of the filtrate is considerable, it is preferable to begin by concentrating to a small bulk before treating with sulphureted hydrogen in heat.

Separation from Silica.—If free sulphuric acid exists in the liquid, it is strongly acidified with hydrochloric acid and evaporated to dryness, at first at 100°; then, when all visible traces of liquid have disappeared, the residue is kept for fifteen to twenty minutes at 120° to 125°.

When cold the mass is moistened with dilute hydrochloric acid and evaporated to dryness a second time in the same manner.

The mixture of silica and the salts of gallium is sprinkled with a little hydrochloric acid, and then heated to 100° for some minutes, in order to dissolve entirely the gallium oxychlorides, which have been formed during desiccation. Care must be taken that no part of the matter is now dried up. Water is then added, and the liquid is heated to near the boiling-point while being stirred.

The silica is then collected upon a filter and washed for a long time, at first with water acidulated with hydrochloric acid, and then with pure water. The gallium is easily extracted from the filtrate by expelling the greater part of hydrochloric acid by evaporation and precipitating with cupric hydrate.

Whatever care has been taken in washing the silica, it retains almost always slight traces of gallium. In an exact analysis, especially if the quantity of silica is large, it must be redissolved in potassa, supersaturated with hydrochloric acid, and treated again as above.—*Comptes Rendus.*

THE TREATMENT OF SEA-SICKNESS BY THE TRANCE STATE.*

By Prof. EDWARD P. THWING.

THE phenomena of the trance have interested me for more than twenty years. For two years my experiments have confirmed the theory of Dr. Geo. M. Beard, that the concentration of the mind's attention in one direction induces an insensibility to other things, more or less complete. President Porter (Elements of Intellectual Science, section 81) says that pure sensation is simply an ideal or imaginary experience, and that, as the perceptional element is made stronger, the sensational is weakened. The intensity of the one is the suppression of the other. Some persons can excite expectancy sooner than others, and so gain control quicker. Some subjects take a consenting attitude more readily than others. One yields instantly, another only after repeated interviews, and some, perhaps, may never yield at all.

Nine cases of sea-sickness, occurring in the Atlantic and in foreign seas, are selected from many, to illustrate the speedy relief, often the complete cure, of this distressing ailment. Some showed little somnolence, while others sank into as complete insensibility as in ordinary anæsthesia by chloroform.

One patient had been unable to retain any nourishment on the stomach after leaving port, two days previous. Manipulations began about the temporal and frontal regions, particularly along the superciliary ridges, and the patient at once exclaimed: "What a heaven to be relieved of pain!" Food was administered in small quantities, and, two hours after, a dinner of roast mutton was relished and retained. The other cases were treated in a similar manner, without the "passes" of the old-time mesmerizer, or the pretentious and dramatic display seen in stage exhibitions, without even fixing the gaze or standing before the individual. The voice probably did more than the hand, but in one case that, too, seemed superfluous: for the sufferer, a brawny Welshman, not understanding English, while busy casting his bread upon the waters, yielded to a pantomime, was led away from the ship side, and made to recline on the shoulder of the operator. The trance became at once so profound that a pin introduced and left in the skin covering the back of the hand caused no wincing. Surgical operations have also been performed, some of which will be described by Prof. Jarvis of Bellevue College. Four facts may be stated as results:

1. The trance state in many cases relieves sea-sickness by restoring nervous equilibrium, and in surgery is sometimes an adequate substitute for ether. Not every one responds. Not every one is able to awaken that faith, belief, expectancy, which Dr. Beard has already shown before this Academy to be the subjective state out of which all these phenomena are evolved. This persuasion cometh not readily to every willing, yielding soul, still less to a reluctant, incredulous mind. Failures are mostly found in two classes. 1. The querulous, dogged, despairing sort, who, at home or afloat, nurse their pains and "enjoy poor health," as they say. 2. The curious, voluble, and volatile, who wish to listen to and join in conversation. But failures with these at the first or second meeting, are by no means final or decisive. Sequestration and silence on the part of the patient, and perseverance on the part of the operator, often secure success in apparently obstinate cases.

2. Tranciform states, *i. e.*, where control is partial and unconsciousness is incomplete, frequently afford proportionate relief.

3. The sense of subjugation and helplessness that comes over one, when in the grasp of Neptune or the surgeon, is sometimes a helpful accessory. It is analogous to the yielding attitude of the animal under a tamer or trainer, and not unlike the paralyzing influence of a panic.

4. The feeling of certainty on the part of the operator is a

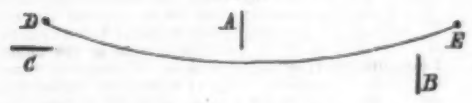
* Abstract from a paper read before the N. Y. Academy of Sciences.

vital factor of success. It cannot be taught. It is gained by victorious achievement. Nothing is so successful as success. One subject under control will spread psychical contagion through a whole assembly, and at once exalt their ideas of the power of the controller. In private practice assurance is better shown by gentleness than by bluster, by undemonstrative, quiet tones, and by the general air of one who speaks a personal, private, authoritative message, which he is accustomed to have immediately obeyed. *Possunt quia posse videntur.* Hardly anything is more contagious than confidence. Nothing is more masterful in power.

BASE BALL SCIENCE.

WE are in receipt of several communications relative to the question of whether a projectile can be thrown so as to describe a horizontal curve during flight. Some of our correspondents favor us with newspaper clippings wherein we

Fig. 1.



are quoted as deciding this problem in the negative. As the only reference to the matter which has appeared in these columns consists in letters from correspondents wherein the writers set forth *their* individual views—and our reply to a question which gave insufficient data, to the effect that we had never witnessed the conditions specified—it is scarcely necessary to add that we have never expressed the formal opinion imputed to us, especially as the views we do hold are diametrically the reverse.

Several learned professors in various Ohio educational institutions having recently embarked in a newspaper controversy as to whether a skillful base ball pitcher could or could not throw a ball in a horizontal curve—the question was set at rest by actual experiment. A chalk line was drawn parallel to the plane of the home plate and first base, Fig. 1. Two sections, A B, of picket fence were placed on opposite sides of the line with their posts upon it. A flat board was placed at C, so that the edge of the board and the inner fence posts were in the same line. The ball was delivered from D with a right hand twist. It passed to the right of A and left of B, and struck the ground at E. When the pitcher stood on the opposite side of C, and threw with his left hand (the position of the barriers being relatively changed), the ball described a curve in the opposite direction.

The mode in which a ball is "pitched," in base ball playing, is shown in Figs. 2 and 3. Fig. 2 is the right hand of

Fig. 2.

Fig. 3.

the pitcher drawn back. Fig. 3 the same purposely thrown forward more than usual to show the hand—the wrist being turned as the arm is swung, and the ball thus given a rotation from right to left. When thus projected the velocity of translation decreases more rapidly than the rotative velocity, which remains nearly constant. This is true of rifle cannon balls, the rotative velocity of which, at the end of their few seconds' flight, is found to be little impaired, although it is not nearly so rapid, the relative velocities of translation being considered, as is that of a base ball. The curve described by the ball, when thrown without twist, is of course in a vertical plane, and in its path it encounters resistance from the air, first, to its forward progression; and, second, to its upward movement during the first part of its flight; while, during the second part of its journey, and while falling, the second resistance of the air is of course opposite to the attraction of gravity. In either case the resultants of these combined resistances act upon the forward portion of either hemisphere, A B, B C, of the projectile approaching A or C, Fig. 4, as the direction of motion more nearly approaches the vertical; or moving toward B as the path of the projectile, traveling in the general direction indicated by the arrow, more nearly flattens. It will be evident,

Fig. 5.

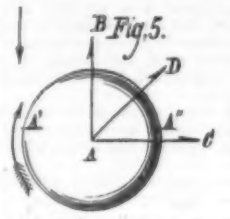


Fig. 6.

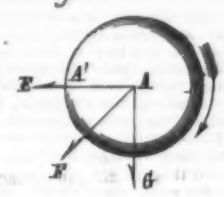
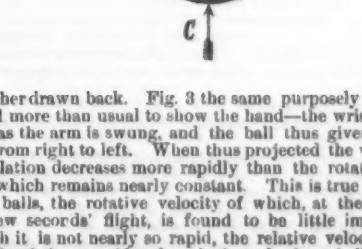


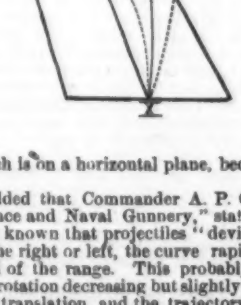
Fig. 4.



however, that over the entire trajectory there will be a vertical component of air resistance, opposing in one case the rising, in the other the falling, of the ball.

Now suppose the ball to be thrown with a twist, as indicated by the arrow in Fig. 5. During the first part of its journey the ball is rising, or moving in direction A B. But the resistance encountered by the side, A', is equal to the sum of the resistances due to translation and that due to the rotation of the ball, while that on the side, A'', is due to their difference. Hence the ball will be thrown to the right or in the direction A C, and its path, after being impelled in the directions AB, AC, will clearly be somewhere between the two, or, for instance, on AD. (In the diagrams the ball is supposed to be traveling from the reader.) This continues so long as the ball rises, but as soon as it begins to fall, Fig. 6, then, the resistance of the air being, from down, up along the vertical A G, the side, A'', of the ball meets the greatest opposition, and hence the projectile is thrown in the direction A E, and hence takes some intermediate path, as A F; consequently the ball during the first part of its flight drifts to the right, and during the second part to the left. The curve described, instead of being in a vertical plane, as X Y Z, in Fig. 7, is in an inclined plane, as X T Z, the projection of which is on a horizontal plane, becomes a curved line, X M Z.

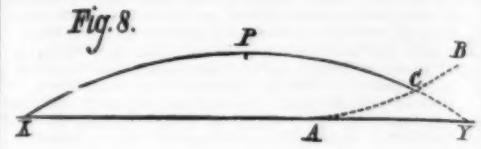
Fig. 7.



It may be added that Commander A. P. Cooke, U.S.N., in his "Ordnance and Naval Gunnery," states that in rifle firing it is well known that projectiles "deviate in a curved line either to the right or left, the curve rapidly increasing toward the end of the range. This probably occurs from the velocity of rotation decreasing but slightly compared with the velocity of translation, and the trajectory is therefore a curve of double curvature, its projection on either a horizontal or vertical plane being a curved line."

A simple experiment in proof of the correctness of the above theory may be made as follows. Let a skillful pitcher accustomed to allow for the twist he gives the ball when throwing it to a given distance, X Y, on level ground, throw with the same allowance to a point, C, at about the same distance off on a hill side, A B, Fig. 8. Now P being the highest point on the trajectory, the ball, for the reason already given, will deviate to the right from X to P. It would then deviate to the left in traveling from P to Y, on

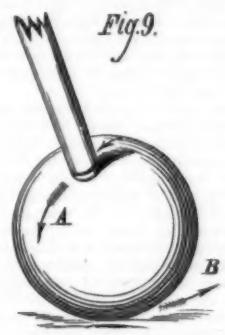
Fig. 8.



level ground, to compensate for this; but in traversing the distance, P C, less than P Y, there will not be sufficient compensation, and hence the estimate of the pitcher should be found untrue, the ball falling, instead of at the point, C, at some point to the right thereof. The converse result is obtained by pitching down hill.

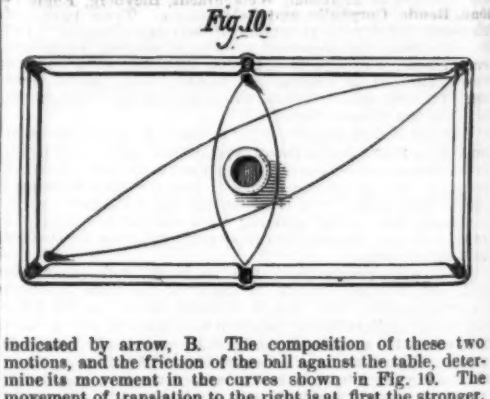
A good instance of a body being propelled in a curved line is afforded by the well known "perpendicular force

Fig. 9.



shot" in billiards, whereby a ball can be made to travel around a hat or other object placed in the center of the table. This is illustrated in the annexed diagrams, Figs. 9 and 10. The ball is struck, as shown in Fig. 9, with the cue elevated at an angle of at least 45°. To cause it to curve to the right it is struck on the left with a quick, impulsive thrust. It thus receives a backward or rather angular twist in the direction of the arrows, and at the same time is given a forward motion or translation toward the right and ahead, as

Fig. 10.



indicated by arrow, B. The composition of these two motions, and the friction of the ball against the table, determine its movement in the curves shown in Fig. 10. The movement of translation to the right is at first the stronger, but eventually the rotating movement, tending leftward, prevails, and the ball at the end of its course inclines towards the latter direction.

AN EGYPTIAN SPHINX UNEARTHED IN ROME.

WE learn from the *Architect* (London) that during the latter part of last month, while some excavations were being made near the Via S. Ignazio in Rome, a very interesting antiquity was laid bare to light. An Egyptian sphinx, which for unknown centuries has been lying there dormant, has now been raised from its cumbent position and has assumed a posture more worthy of its age and dignity. While the workmen were trying to dislodge their curiosity from its bed in the earth, the picks of one of the excavators struck against a section of stone, which was found to be granite, and upon examination it was discovered that a monolith with its four sides covered with hieroglyphs was lying there side by side with this sphinx. This obelisk is judged to be about the same size as the one which now stands on the back of the elephant in the Piazza della Minerva.

The Archæological Commission is now considering the propriety of purchasing the objects unearthed, and of prosecuting the excavations. Readers may remember that the obelisk mounted, by a whim of Bernini's, on the back of an elephant in the Piazza della Minerva was found in 1665, in the garden of the Dominican fraternity attached to the church, and that it, too, came from the Temple of Isis. From the same source comes the obelisk in the front of the Pantheon, which, at the instance of Clement XI., was erected as the center piece of the fountain in the piazza.

The obelisk just exhumed, from the site of the Temple of Isis and Serapis, has been found to bear the name of Pharaoh Rameses II. of the nineteenth Theban dynasty. It belongs to the fourteenth century before Christ; but the question arises whether it is an original Egyptian work or a replica made in Roman times. Signor Lanciani, who superintends the excavations on the above site, announces that the sphinx in black basalt lately disinterred, and now placed in the capitol, represents Pharaoh Amasis, the last but one of the Saitic dynasty.

THE MANUFACTURE OF ZINC.*

By M. ST. PAUL DE SINÇAY, of Chênée.

On the whole it appears that Belgium now possesses eleven works for reducing zinc ores, and all in a state of high activity. Their capacity has developed gradually, and in 1882 they were able to turn out 71,565 tons of raw zinc. The following table gives the distribution of this total make:

Works.	Tons.
Vieille-Montagne	35,940
Austro-Belge	8,099
De Laminne	6,255
G. Dumont et Frères	5,500
Nouvelle-Montagne	5,480
Bleyberg	4,647
Ougrée	4,144
Prayon	1,500
	71,565

This total figure represents about one-third of the whole production of Europe, but will probably be considerably surpassed in 1883. In so active a state of trade it is not to be wondered at that the annual amount of ore consumed is considerable; it is, in fact, about 200,000 tons, only a part of which is furnished by the mines of the country. Belgium, as we have said, is rich in zinc-bearing strata; some of them consist of calamine, others of blende, mixed with sulphates of iron and of lead. The greater part of these are under concession, and are worked to a greater or less extent. The principal concessions have already been mentioned; the others would form a long list which it is not worth while to give. For several years calamine (carbonate of zinc) has been the only ore treated in the Belgian zinc works. The preference thus given to it is easily explained by the facility with which it lends itself to metallurgical operations. For a long time it was believed impossible to utilize the blende (sulphite of zinc); but thirty years ago the making of zinc began to be largely extended, and it was necessary to have recourse to new supplies of mineral. Attempts were then made to make use of blende; special workshops were constructed for the desulphurizing of the new ore, and before long a considerable proportion of this ore was supplied to the foundries. In Belgium the chief works for roasting blende are those of Bleyberg, Engis, Flône, Ampsine, Corphalie, and Sclaigneaux.

It would be difficult to estimate the quantity of zinc ores, carbonates, and sulphides together, which have been extracted from the Belgian mines. It must be very great, since from 1887 to 1882 the mine of Moresnet Neutre alone, belonging to the Vieille-Montagne Company, produced 1,295,290 tons of calamine. The calamine earths, which are found with the ore-bearing rock, are generally very poor in zinc, but are made more serviceable by washing. The same is the case with the blende, which must be separated from the other sulphides with which it is almost always associated; but on account of this separation the mechanical preparation of blende gives rise to operations which are usually of a very complicated character. Belgium possesses several large works for the mechanical preparation of zinc, such as those of Moresnet, Welkenraedt, Bleyberg, Engis, Flône, Bende, Corphalie, and Sclaigneaux. These have a high reputation for the excellence of their manufacture. In several of these, appliances which are now known and appreciated throughout the world have had their origin. Except the Moresnet works, which only treat calamine from the neural territory, all the Belgian foundries receive a part of their supplies of ore from abroad. It was the mines of Spain which first came in to aid in their supply; to these were subsequently joined those of Sardinia, Greece, Algeria, Sweden, France, Germany, and England.

Foreign calamine is generally calcined before being shipped; blende, on the contrary, is usually shipped in its raw state, and has to be submitted in Belgium to the preparatory treatment which its nature requires. Almost all these ores are brought by sea to Antwerp, where several agencies exist to receive them, and direct them toward the zinc works, whether by railways, with which all the works are connected, by canals, or by the Meuse, most of the works being equally accessible by the latter channels.

The Belgian foundries require from abroad nothing more than a supply of ore; for everything else they find in their own country and neighborhood all the resources necessary. Situated in more or less close vicinity to numerous collieries, they can choose the bituminous coal best suited to the system of furnace they have adopted. They receive from different sides, both from the basin of the Charlerol and that of Liege, non-bituminous coal and smail coal, which they employ for reducing purposes. It is well known that for the manufacture of zinc, as for many others, the question of refractory materials is of very high importance. The Belgian works obtain from large beds near Ardenne a refractory clay, with which they manufacture articles of an excellent quality, and of long established reputation.

But the special strength of these works lies in the fact of their possessing a class of workmen, strong, intelligent, experienced, active, well disciplined, fond of their trade, and deeply penetrated with feelings of duty. Among this industrial population, which, without counting laborers, numbers some 7,000 workmen, there are many who have saved enough to buy the houses which they inhabit, and the gardens which, after the rough labors of the shop, they find time to cultivate themselves. The workmen at the Valentin Cocq works belonging to the Vieille-Montagne Company are distinguished in this respect, since at least half of them are proprietors. This love of property and care for the future is nothing surprising. For a long time past the company has done its best to inspire this feeling by creating institutions of thrift intended to insure the material, moral, and intellectual good of the working classes.

The first care of the company was to give all their workmen a share in the wealth which they procured proportional to their efforts and their success. The arrangements as to wages and allowances were made in this spirit. Subsequently the work was completed by establishing the following institutions, all intended to ameliorate the condition of the workmen, namely: A sick fund, a provident fund, a savings bank, and a life insurance fund. The two first are workmen's institutions in the full sense of the word; the sick fund is formed entirely by a sum deducted from the workmen's wages, and is used to supply their present needs in case of sickness or injury. The provident fund, which is supplied by payments from the company, is intended to provide for the future need of the workmen when age or infirmity renders him incapable of labor. This solicitude for the working classes on the part of the Vieille-Montagne Company has been imitated under different forms by the other Belgian works; and these measures have received a practical sanction which is worth noting, namely: That, so far as the writer knows, this industry has been wholly free from those strikes which have so often brought disaster into the trades of the miner and the ironworker.

* Abstract from a paper lately read before the Institution of Mechanical Engineers, summer meeting at Liege, Belgium.

THE METALLURGY OF ZINC.

The different processes for the reduction of zinc ores are well known. The *per descensum* process has scarcely ever been practiced except in England. On the Continent the methods in general use are the Liege method and the Silesian method. Neither of these since its commencement has undergone any essential change, and they may be employed at present side by side with each other. The Liege furnace is generally higher than its width, and contains six, seven, or even eight ranges of crucibles. These furnaces occupy little space, and also consume less fuel than the Silesian furnaces. The latter, on the other hand, are cheaper as regards labor and the durability of the distilling apparatus. To complete the essential distinctions between the two, it may be said that the Silesian furnaces are specially adapted for treating poor ores; and this should be so, since they were invented to reduce the calamines, low in proportion of metal, which are worked in Silesia.

Belgium, as might be expected, has remained faithful to the Liege or direct heating process, inaugurated by Dony. The works of Valentin Cocq and Flône are the only ones which possess furnaces agreeing with the Silesian system in their mode of heating; but being provided as they are with crucibles in three ranges, they share equally the advantages of the Liege method. Great efforts have been made to perfect the metallurgy of zinc. These have opened the way to progress in many respects. In all the operations required—in the preparation of the refractory materials concerned, in the crushing of the ores, in the composition of the charges, in the construction of the hearths, in the arrangements and dimensions of the heating chambers—important improvements have been realized; in all new and improved appliances have come into use, which, for the most part, are due to eminent manufacturers in the district. Above all, changes have been made tending to render more easy and less dangerous the labor of the workmen. Thanks to other improvements, the results of the process have been sensibly improved. It has especially been sought to augment the production of the furnace, to reduce the "ecart" or loss of metal during treatment, and lastly to diminish the consumption of fuel. In all these ways notable progress has been realized. The zinc vapors formed in the crucibles are condensed in receivers, made of refractory earths and called tubes or bottes. From these the liquid metal is withdrawn, either several times during the operation or once for all at its termination, and it is immediately run into ingots or rectangular plates, of a thickness from 20 to 25 mm. (0 8 inch to 1 inch), and weighing about 20 kilogrammes (45 lb.).

The first products of the distillation are collected in the form of dust, more or less oxidized, in wrought-iron pipes which form a prolongation of the tubes. This dust, to which has been given the name of gray oxide, must be submitted to a fresh treatment unless it can be utilized directly for painting, or for the making of hydro-sulphite of soda. The second treatment is sometimes carried out in a furnace with vertical retorts, which bears the name of its inventor, M. Montefiore, and which is worked particularly at the Corphalie manufactory. The ingots of raw zinc are, some of them, taken to a rolling mill and rolled into sheets. Others are reserved for making oxide of zinc, and others, lastly, destined for different industries, such as the making of brass, are sold in the condition in which they leave the foundry.

ROLLED ZINC.

The uses of rolled or sheet zinc are numerous and varied. New uses are created every day. The consumption of rolled zinc, which has long been been large, increases continually, and the greatest part of the zinc produced in Europe is not used until it has been passed through the rolls. The rolling of this metal at first encountered very great difficulties. These arose from the fact that its malleability is confined between very narrow limits of temperature. For this reason the rolling of zinc will always remain a delicate operation, which can only be intrusted to experienced hands. The most suitable temperature is about 100° C. = 212° F., and this must be maintained through the whole of the process. Below this point the metal opposes too great a resistance to the squeezing action of the rolls; and it must be reheated, which is a matter of much inconvenience. Above this point it becomes brittle; at 200° C. = 390° F. it can be brayed in a mortar. Whatever its method of manufacture, zinc ought to be remelted before being rolled into sheets. The heat of fusion varies between 400° and 500° C. or 750° and 930° F. Remelting is generally accomplished in a reverberatory furnace. Its first advantage is that it rids the zinc of the impurities, especially lead, which almost always accompany it. Again, the thickness of the ingots must vary with the final dimensions required: this is another consideration which renders remelting indispensable. The remelted plates are first roughed down or rolled between heavy rolls; then, after being cut down to a fixed weight, they are conducted to the finishing train, where the rolling is completed. There are therefore two distinct operations—the roughing down and the finishing. Between the two the sheets should be reheated in annealing boxes placed upon the melting furnace, so as to utilize the waste heat. Each of these operations gives rise to a production of scrap, which is more or less large according to the quality of the metal and the tenacity of the sheet. This scrap, as well as any defective sheets, are remelted with the ingots coming from the foundry. On leaving the finished rolls, the sheets are cut by shears to a retangular shape, and to the dimensions required by commerce. There are several systems of shears; those most used in Belgium are the lever shears and the guillotine shears. The latter, which at present have the preference in the rolling mills of the Vieille-Montagne Company, cut the metal perfectly clean and exact.

After being squared, the sheets of zinc are sorted with great care. Those which are found to answer all the conditions are impressed with the stamp of the works. The thickness is specially gauged, and is expressed by a number on a fixed scale. It varies between 0·05 millimeter and 4 centimeters (0·002 inch to 1·575 inches). Zinc sheets are delivered sometimes loose, generally in barrels or boxes; hence a cooperage is an indispensable adjunct to a store for rolled zinc. This accessory is mentioned on account of its real importance. Belgium manufactures annually nearly 40,000 tons of sheet zinc. The rolling mills which contribute to this production are, in the first place, those of the Vieille-Montagne Company at Angleur and Tilff, which together furnish nearly 20,000 tons per annum. The remainder of the make is divided between the works of the Nouvelle Montagne Company, at Engis; those of the Societe de Prayon, at Prayon; those of MM. Francotte-Pirlot & Co., at Chênee and Liege; those of M. E. Nagelmackers, at Chaudfontaine; those of M. Charles Heptia-Hauzeur, of Fraipont; those of Madame Veuve Bonhomme, at Nessonvaux; those of MM. Lejeune Freres, at Stere; those of M L. Dacier, at Liege; those of M. J. Brasseur, at Huy; and those of M. G. Schmidt, at Brussels.

As already stated, the applications of rolled zinc are numerous and varied. We will confine ourselves to a few. The making of roofing sheets certainly occupies the first rank. The systems vary according to the character of the buildings to be covered. For dwelling-houses choice may be made between plates having the shape of a heart, a lozenge, a fish-scale, a rectangle, etc. All are recommended by many advantages; among which should be specially noted their complete impenetrability to water. Roofs for industrial buildings are generally constructed of fluted or corrugated zinc. Among other applications some of the chief are the sheathing of vessels; the making of domestic utensils and articles for various trades, for many of which the zinc must be previously pierced with holes; the glazing of paper; the making of tacks and of wire. In thick plates zinc is chiefly employed by engravers for zincography, in arsenals for coating bullets, and in steam boilers to prevent incrustation.

OXIDE OF ZINC.

Zinc heated to a red heat is evaporated, and the vapor coming in contact with air is oxidized and produces a white impalpable substance, which alchemists named *lana philosophica*, and which in modern times bears the name of "zinc-white." This oxide has long been employed for decorative painting. Its brilliant whiteness, combined with the fact that it does not change by the action of the air, and has no ill effects on the workmen who use it, are the principal qualities which have made it the most formidable rival to white lead. In making oxide of zinc there are two processes equally simple. The sublimation process is the most ancient. To sublime or volatilize ingot zinc, it is placed in a series of retorts within a common furnace; the oxide is formed in an exhaust chimney, and then passes through a long series of passages and condensing chambers. It is deposited in large tanks of sheet iron or cloth, which are ranged all along the path pursued by the vapors. At certain hours in the day the oxide is collected into casks, and then, after the quality has been tested, it is compressed into barrels carefully made, and is ready for delivery. According to the purity of the metal subjected to the process, the zinc-white is obtained, varying in color and brilliancy. "Blanc de neige" is a product of the most superior quality, and can only be made with zinc from the ores of the Moresnet beds. "Blanc No. 1" is the most common variety. It requires for its manufacture zinc coming from selected ores, and generally purified by remelting. Lastly, "Blanc No. 2" is the common variety, distinguished from the others by its shade of whiteness, though still identical in composition.

In the making of zinc-white, as in all other manufactures, residues are produced. Drops of metal imperfectly oxidized, deposit in the retorts, and waste from the workshops, are all classed separately; then, after being ground, washed, and dried by being led through winding passages, they form the "gris-pierre" which is employed in painting to replace minium. The second process for making zinc-white is known as the American method. It uses the ore direct, and is necessarily therefore cheaper than the former; but its products are of inferior quality to those produced by sublimation. There are in Belgium only two works for making zinc-white. The Vieille-Montagne Company produces annually at the Valentin Cocq works 3 000 tons of zinc-white by sublimation. The other work is at Ougree, and belongs to Messrs. Eschger, Ghesquiere & Co. There the American method is employed, but at present the works are standing idle.

DIRECT USE OF INGOT ZINC.

As we have said, zinc was employed in the arts long before it was known in the metallic state. As of old, the making of brass continues to absorb the largest quantities in Belgium, and above all in England. Melted zinc is also used to cast ornaments and objects of art, such as statuettes, groups, etc., which are afterward covered with copper by means of the galvanoplastic method, and imitate bronze with a perfection which defies the most skillful eye. The Vieille-Montagne Company makes from the ores of Moresnet, under the name of *fonte d'art*, a variety of zinc which is specially reserved for this purpose. Lastly, the galvanizing of iron, telegraph wires, etc., is a large source of employment for ingot zinc.

If the zinc works of Belgium receive a part of their supplies of ore from abroad, in return their products are exported into all the countries of the world. France and England are those which receive the most; Germany, Italy, America, Scandinavia, and Holland also take their share.

In conclusion, the manufacture of zinc, the origin of which in Belgium dates back to so remote a period, has received from the beginning of this century a very large development. By the number of establishments devoted to it, by the quantity and value of the production, by the multitude of workmen it employs, by the importance of the capital which it absorbs, it holds one of the foremost places in the great industrial life of the country. In spite of the depreciation in value of all metals, the production of zinc increases from year to year, and the financial results of the operation are in general satisfactory. The working of zinc has a brilliant past, and it may be hoped that it will still enjoy in Belgium a long era of prosperity.

MAKE OF CRUDE ZINC IN EUROPE SINCE THE YEAR 1860.

District.	1860.	1865.	1870.	1875.	1880.	1882.
	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.
Upper Silesia	40,354	35,430	36,518	43,123	65,497	69,856
Rheinprovins and Westphalia	8,502	16,647	18,006	25,396	27,107	35,546
Vieille-Montagne	28,925	30 502	48,112	41,618	44,690	48,851
Other Belgian makers	9,144	13,485	14,476	18,836	26,700	35,645
Asturas } Spain	1,777	1,225	3,048	3,000	4,000	5,047
Company } France	—	—	—	5,311	8,291	11,428
Other French makers	—	500	500	1,500	3,000	—
England	6,104	6,523	16,000	15,903	22,000	25,581
Poland	1,500	3,000	3,825	3,000	4,463	4,544
Austria	1,500	1,000	1,000	1,000	3,199	3,199
Total	97,896	108,502	135,285	159,687	209,187	239,673

THE ECLIPSE OF THE SUN.

FAVORABLE weather and the best of good fortune attended the parties of astronomers who were stationed to observe the eclipse of the sun, on May 6, 1883, on a little island 12,000 miles distant. They had to note and record a celestial phenomenon of only five minutes' duration. But we know little of the immediate surroundings of our luminary, save what has been gathered during total eclipses. The only places from which this eclipse could be seen, except as a partial eclipse of no use to astronomers, were Flint and Caroline Islands, in the very center of the great Pacific. To the last mentioned islands, in latitude 10 deg. south, longitude 150 deg. west, went the English and American observers in the United States ship Hartford, famous for the part she took in the American civil war. To the same island went also the French vessel L'Eclaireur, with Messrs. Janssen, Trouvelot, Palisa, Tacchini, and Pasteur. The little coral atoll, a group of islands encircling a lagoon, scarcely seemed a very convenient place for such an operation. The formidable coral reef surrounding it appeared with scarcely an opening where boats might land safe from the huge breakers which fringed the islands with a line of white foam. Even when the heavy instruments had with difficulty been landed and carried in shore, passing clouds and rainstorms augured ill for the success of the works. Groundless were such fears, however, for at the time of the eclipse a much better and clearer sky could scarcely have been wished.

Some idea of the scenery of the place may be obtained from the accompanying illustrations. A bright, calm lagoon is bounded in the distance by a thin line of coral reef, separating it from the rougher water beyond. Tropical trees, some covered with foliage, others nearly bare, stand as in the picture, where the naked branches stretch out over the water, at one of the extreme points of the southern island. In the foreground are rough shrubs and fine grasses, with here and there trunks and branches of dead trees, such as the pandanus, and, at regular intervals, the beautiful young cocoanut trees, planted by the present owners. The astronomers were fortunate in finding two wooden dwellings. The one shown here in the shade of the cocoanut palms was situated on the shores of the lagoon, and here, under the veranda, the English and American astronomers slept at night, or rested in the shade during the hotter parts of the day. Close to the house was their encampment, the large tents of the United States Coast Survey being the most prominent objects. Near these tents stood the spectroscope hut and equatorials of Messrs. Lawrance and Woods. Just behind these instruments were the tents of Professor Holden, Dr. Hastings, and Mr. Rockwell; and yet a little further to the rear, just where a group of trees marked the boundary between the encampment and the barren broken coral of the seashore, stood the flagstaff, which carried the British flag, hoisted by the friendly Kanakas on the arrival of the strange ship. The last illustration shows the encampment as it appeared on the eventful morning, with the observers standing at their instruments waiting for the sun to disappear.

We are indebted to Mr. R. A. Lawrance for the views engraved, and Mr. C. R. Woods has supplied the above descriptive notes.—*Illustrated London News.*

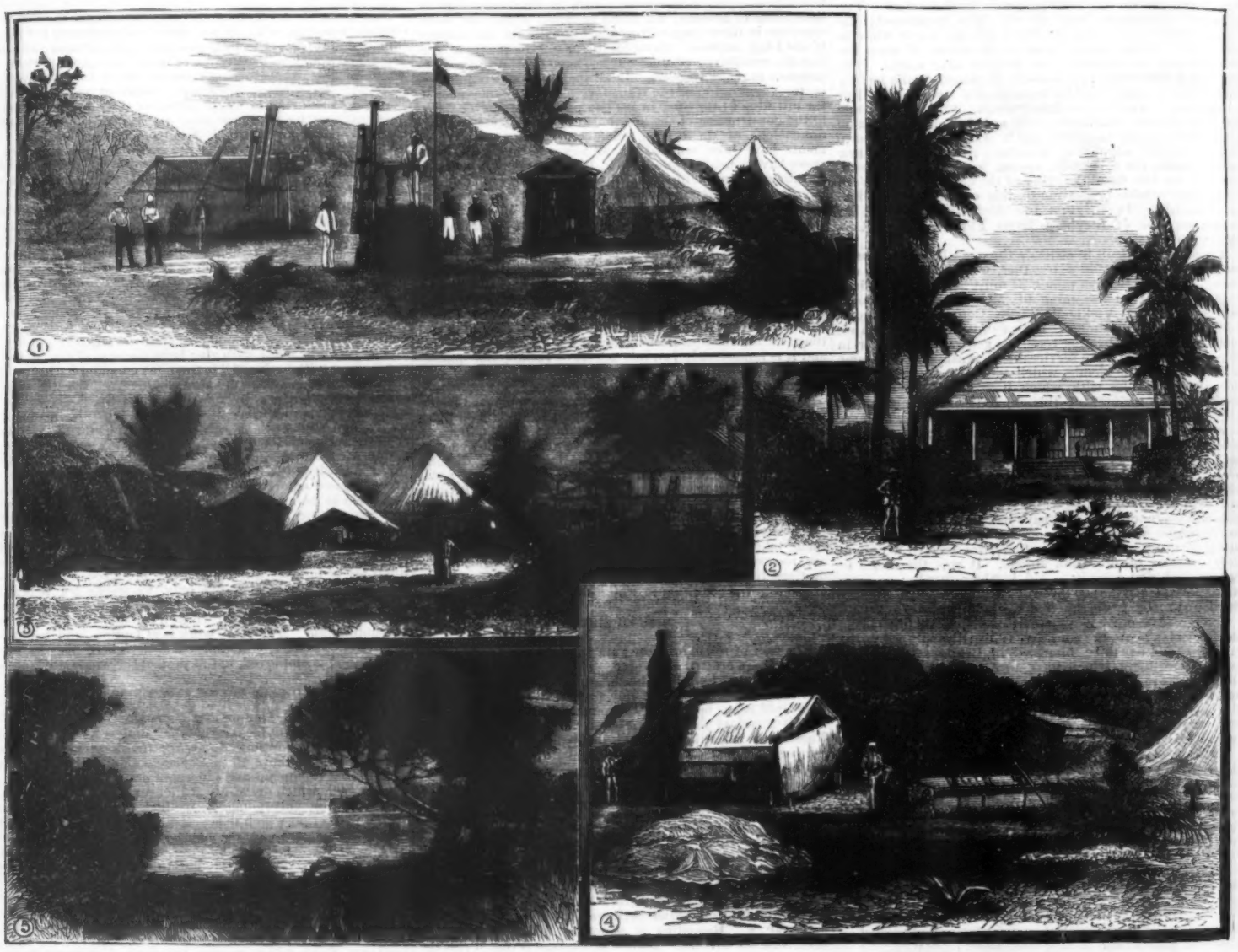
For a more full account of this eclipse, see the SUPPLEMENT, No. 400.

THE MASS OF JUPITER.

WHEN an astronomer makes the statement that a planet contains a certain amount of matter, or that it is from the sun a given distance, and that its diameter is so much greater or less than the earth, the majority of people feel that as a matter of necessity the results must be mere guesses. We hope in as brief and plain a manner as possible to call attention to one of the methods of determining the quantity of matter in a planet having a satellite. We accordingly take the planet Jupiter, as it has four moons. It may be well for us to say here that our estimate of the mass of a planet depends on our knowledge of the sun's distance from the earth; this problem has been prosecuted with most consummate skill in all civilized nations, and the results are indeed with a good degree of precision, the horizontal parallax of the sun being not far from 8·81 seconds, giving, according to Prof. Young, a distance of 92,885,000 miles as the interval between the earth and sun. With this base line quite near the truth, and with the various observations with the micrometer on Jupiter's satellites, we can with a good degree of complacency assert the mass of Jupiter. The micrometer is a small instrument that is placed at the eye piece of the telescope arranged with a tangential screw, the value of whose revolutions have been determined; within are two spider lines so constructed that by turning the screw at the side the line can be made to move across the field of view. Now, if the apparent diameter of a planet is desired, the astronomer brings one of the spider lines tangent on one side of the planet, and then moves the other line by means of the screw so it will be just tangent to the planet on the other side: reading the number of revolutions or parts that he has turned the screw, it will give him the angle subtended by the planet. So in determining the distance of one of the satellites of Jupiter, one line is brought tangent to the planet, and the other line tangent to the satellite; by using great care in reading the value of the angle as recorded by the screw, you will obtain the distance separating the planet from the satellite, in arc, and by knowing the distance of Jupiter from the earth, and having the line between the earth and Jupiter drawn at right angles to Jupiter and the angles just measured by the micrometer, you have one side and two angles of a triangle, from which the remaining two sides and angle can easily be obtained. In case of the first satellites the distance from Jupiter in arc is 111·82 seconds, corresponding to an actual distance of 260,000 miles. The second in arc equals 177·81 seconds; distance in miles, 414,000. The third measured in arc from Jupiter is 283·68 seconds; in miles, 1,162,000. For this carefully prepared table we would refer the reader to Newcomb and Holden's Astronomy, page 351.

Having the mean distance of Jupiter from the sun, and the time of its revolution around the sun, also the distance in miles of one of the satellites, and the time of revolution around Jupiter, we have by simple proportion, based on elementary geometry, a statement as follows: Let M equal the mass of the sun, and *m* the mass of Jupiter. Then, M is to *m* as the cube of Jupiter's distance from the sun divided by the square of the time of its revolution is to the cube of the satellite's distance from Jupiter divided by the square of its time of revolution. From this proportion we can find the excess of matter in the sun as compared with Jupiter; this amount differs somewhat, depending on which one of the satellites you take. We may say that the results obtained by Dr. Wilhelm Schur are among the most satisfactory; he having at his disposal four excellent heliometers, secured one hundred and seventy-six measures of distances, and one hundred and fifty-four measures of position-angles of the four satellites, which he very carefully reduced, requiring much skill, as temperature, the periodic error of the micrometer screw, and the error of the supposed value of a revolution of the screw, were all taken into consideration. The value obtained by means of the first satellite, that is, the reciprocal of mass, or $\frac{1}{1047\cdot879} \pm 1\cdot125$. For the second satellite $\frac{1}{1047\cdot888} \pm 0\cdot902$. For third satellite $\frac{1}{1047\cdot888} \pm 0\cdot486$. For fourth satellite $\frac{1}{1047\cdot879} \pm 0\cdot327$. Combining these by weight, the reciprocal of the mass of Jupiter is $\frac{1}{1047\cdot888} \pm 0\cdot246$, that is, the sun weighs 1,047 and the decimal times more than Jupiter. And as the sun according to the latest results contains 330,000 times as much matter as the earth, we can readily find how much Jupiter exceeds in weight the earth, by dividing 330,000 by 1,047; neglecting the decimal, this gives about 315 times more matter in Jupiter than in the earth. When we recall that Jupiter is moving at a mean distance from the sun of four hundred and eighty-one millions of miles, and at an average velocity of not far from eight miles in a second, we can in a measure appreciate the controlling power of the sun, which makes this huge mass of moving matter turn through four right angles at its removed post in about twelve years. As was remarked, we only called attention to one method of arriving at the mass of Jupiter. We will mention however that in 1821 Bouvard, by the perturbations of Saturn, found Jupiter's mass $\frac{1}{1071\cdot3}$ part of the sun, and Nicolai by the perturbations of Juno $\frac{1}{1071\cdot333}$. In 1871, Möller, by the perturbations of Faye's comet found $\frac{1}{1071\cdot733}$, which it will be observed comes very close to the results of Dr. Schur.

HENRY A. SMITH.



1.—Encampment on the morning of the Eclipse. 2.—Astronomers' House. 3.—Spectroscope Hut. 4.—Tents of the United States Coast Survey. 5.—Lagoon.

THE ECLIPSE OF THE SUN, MAY 6, 1883, SEEN FROM CAROLINE ISLAND IN THE PACIFIC OCEAN.

A TABLE has been published showing the elevations of the higher points in each ward of Philadelphia above high water. The greater part of the city in area and population is on a plateau not exceeding fifty feet high, and for the most part much lower. Three-fourths of the population live on a plateau whose greatest elevation does not exceed 113 feet. One-third of the remainder live in West Philadelphia, and only 50,000 out of 850,000 in the two wards of very high elevations.

[THE GARDEN.]

THE AILANTO, OR TREE OF HEAVEN.*

MORE than a century has elapsed since this fine tree first found its way to European gardens, and its merits as a useful shade and ornamental tree of the first class are now generally recognized. It is a native of China, and its exact date of introduction from that country is pretty certain. The following memorandum occurs in "Hortus Collinsonianus:" "A stately tree raised from seed from Nankin in China, in 1751, sent over by Father D'Incarville, my correspondent in China, to whom I sent many seeds in return; he sent it to me and to the Royal Society." Few trees are less particular as to soil or position; in slightly sheltered spots in moist, fairly good ground it, however, grows most rapidly, and soon attains a large size. In France it is said to thrive on chalky soils, and to get a large size where scarcely any other tree will grow. Mr. Robinson, in his "Parks, Promenades, and Gardens of Paris," pays it the following tribute: "Ailantus glandulosa – sometimes called the Tree of Heaven, and by the French Vernis du Japon—is a town tree of great excellence. When in a young state it is graceful from its long pinnate leaves; when old and well grown, it becomes a graceful forest tree. But the qualities that will above all others recommend it to the town planter are its perfect health and freshness under all circumstances in towns. Dust, foul air, or drought seems to have little or no effect upon it. For parks and avenues it is indispensable, as it perfectly retains its foliage long after our own deciduous trees have been scorched by drought and dust. It seems to do equally well on all soils, having a constitution and a leathery texture which seem perfectly indifferent to any vicissitude of climate witnessed in these latitudes."

The small greenish white flowers, in spite of the number in which they are produced in the branched panicles, are inconspicuous enough, but when these are followed by innumerable fruits—somewhat like the keys of an ash, but rather smaller—tinted with bright red brown, the general effect is quite different from, and perhaps superior to, that produced by any other hardy tree. A large specimen at Kew last year proved, with a background of dark pines, to be for the time the most attractive object in the arboretum.

For so-called sub-tropical work, the ailantus, if cut back annually and kept to one growth, grows rapidly, and produces foliage of enormous proportions. It assumes a most tropical appearance, and looks much unlike a plant which requires no care or expensive quarters during the long winter months.

The ailantus, too, acquires additional interest as the food of the silk-producing insect (Bombyx cynthia), which of late years has been introduced into South Europe and Algeria. In its native country its leaves are used as a vegetable in times of scarcity, and recently Dr. Robert, the Inspector-General of the Health Service in the French Navy, has called attention to the fact that the root bark affords a very valuable specific in cases of dysentery. The leaves are, in this country at any rate, not liable to the attacks of insects, which in the case of so many cultivated trees do so much harm at times, not taking into account the disagreeable appearances caused by their ravages. Horses and cattle, and it is said even goats, refuse to eat the leaves. The wood, according to Desfontaines, is hard, heavy, glossy like satin, and susceptible of a very fine polish.

Varieties.—The names of Ailantus macrophylla, A. japonica, A. rubra, A. purpurascens, and A. mascula pendula, found in foreign catalogues, do not in all probability (with perhaps the exception of the last named) represent even slight varieties. The form with variegated leaves mentioned incidentally by Koch in his "Dendrologie," seems to be rare. The Ailantus flavescens of gardens belongs to a different genus, and was determined by M. Carriere to be Cedrela sinensis, Juss. Ailantus is readily raised from seeds, but when these are not to be had, root cuttings furnish an easy method of propagation.

Statistics.—The following data are taken from Loudon's "Arboretum." It would be both useful and interesting were present measurements of these trees to be forwarded to the editor of this journal.

In the Environs of London.—The largest tree is at Syon; it is 70 feet high, the diameter of the trunk 3 feet 10 inches, and of the head 40 feet; the trunk forms an erect column of 30 feet before it branches, and the head is hemispherical. In the Fulham palace there is a tree, twenty years planted, which is 25 feet high.

South of London.—In Kent, at Cobham Hall, twenty years planted and 36 feet high, the diameter of the trunk one foot, and of the head 15 feet; in the Isle of Jersey, in Saunders' nursery, ten years planted and 16 feet high; in Sussex, at Langham Park, nine years planted and twelve feet high; at Kidbrooke, thirty years planted and thirty feet high.

North of London.—In Bedfordshire, at Ampthill Park, three years planted and 12 feet high; in Berkshire, at White Knights, there are several trees nineteen years planted, and from 27 to 30 feet high; the diameter of the trunks about nine inches, and of the heads about 30 feet; these trees produce flowers every year, and fruit occasionally. In Cambridge, in the grounds of St. John's College, there are two trees, both near the River Cam., one of which is 40 feet high, with a trunk 2 feet 7 inches in diameter; in Warwickshire, at Coombe Abbey, ten years planted and 12 feet high; in Worcestershire, at Croome, 45 years planted and 60 feet high; the diameter of the head is 90 feet.

Scotland.—In Berwickshire, at the Hirsel, three years planted and 6 feet high; in Perthshire, at Kinfauns Castle, eight years planted and 16 feet high; in Sutherlandshire, at Dunrobin Castle, 43 feet high, the diameter of the trunk 1 foot 6 inches, and of the head 33 feet.

Ireland.—At Dublin, in the Glasnevin Botanic Garden, twenty years planted and 18 feet high; at Terenure, twenty years planted and 14 feet high.

Foreign Countries.—In France, at Paris, in the Jardin des Plantes, 68 feet high, with the head 44 feet in diameter; at St. Leu, where it was planted on a large scale by Mr. Blaikie in 1794, it is 80 feet high, with a trunk from 3 feet to 3½ feet in diameter; in the Botanic Garden at Toulon, fifty years planted and 60 feet high. At Geneva, at the entrance to the Botanic Garden, there is a tree from 45 feet to 50 feet high, the trunk of which, in 1883, measured 7 feet 3 inches in circumference at the surface of the ground. In Saxony, at Wörlitz, a tree twenty years planted is 25 feet high. In Austria, at Vienna, in the University Botanic Garden, forty years planted, 35 feet high. In Prussia, at Sans Souci, thirty years planted and 20 feet high. In Bavaria, at Munich, in the Botanic Garden, twenty years planted and 20 feet high. In Hanover, at Göttingen, in the University Botanic Garden, ten years planted and 30 feet high. In Cassel, at Wilhelmshohe, 60 feet high. In Italy, at Monza, twenty-nine years planted and 60 feet high.

GEORGE NICHOLSON.

Royal Gardens, Kew.

* "Ailantus glandulosa, Desf. Act. Acad.," Paris, 1786, p. 263; Loudon, "Arboretum et Fruticetum Britannicum," vol. i., p. 490; Koch, "Dendrologie," theil i., p. 589.

THE AILANTUS IN A YOUNG STATE, WITH FLOWERS, FRUIT, AND FOLIAGE.

FULL GROWN TREE OF AILANTUS GLANDULOSA, HEIGHT 70 FEET.

[AMERICAN NATURALIST.]

NATURAL HISTORY NOTES.

SOME NEW MAMMALIA OF THE PUERCO FORMATION.

AT a recent meeting of the Philadelphia Academy, Professor Cope stated that he had recently received from the Puerco beds of New Mexico remains of a number of individuals of the extinct mammal he had named *Periptychus ditrigonus*.* Besides jaws and teeth with permanent and temporary dentition in good preservation, the pelvis, femur, and tibia are included in the specimens. These show that the species must be referred to the genus Conoryctes Cope, and render it very probable that the genus belongs to the family of the Periptychidæ. The absence of ungual phalanges prevents absolute certainty. The genus is near Periptychus, but differs in the one root and simple conic crown of the second true molars in both jaws, and the presence of cingular cusps of the superior molars, exterior to the external tubercles. *Conoryctes ditrigonus* has the molars of both jaws larger than those of the *C. comma*, and there is less difference in size between the posterior and anterior teeth than in that species.

The following new species accompanied the above: *Periptychus coarctatus*, *Puntolambda cavirictus*, and *Zetodon gracilis*, gen. nov. The second named is the largest mammal of the Puerco epoch yet known, equaling a full-sized tapir in its jaws. The genus Zetodon was thus defined. The true molars consist of narrow crescents in two pairs, which are both concave toward each other, embracing a fossa. The posterior crescents soon unite on attrition, closing the fossa, while the anterior are well separated, and only unite by their anterior apices. Each has a small, columnar heel. Fourth premolar with the posterior pair of crescents only, which soon unite. The anterior pair is represented by a part of the external one which forms a narrow lobe. The heel is larger than in the true molar.

The position of this genus it is impossible to determine from the specimens obtained. It may be Marsupial or Condylarthrous, and, if the latter, one of the Meniscotheriidæ;

* Proceed. Amer. Philos. Society, 1882, p. 465.

but if not of these groups, its position is not likely to be in any known order of the Tertiary periods.—*Amer. Naturalist.*

THE GROWTH OF PLANTS IN ACID SOLUTIONS.

The watering of plants with alkaline solutions, soluble phosphates, and organic extracts has been very extensively and variously experimented upon, but any comparative examination of a series of plants treated under the same conditions with acid waters has not to my knowledge been published. The experiments described below originated in an inquiry as to what extent acids would affect vegetation, and whether apprehensions aroused by the reported destruction of trees through acid precipitation from manufactures were justified.

The plants experimented with were specimens of the silver-leaf geranium, so commonly used in combination with the fish geranium in ornamental flower beds, both being varieties of the same species perpetuated by the gardener's skill and selection. Ten plants in very nearly the same conditions of growth, size, and characters were potted in good garden mould with manure, and were watered with solutions of nine acids and with ordinary rain water, the same solution being applied to one plant throughout the season uninterruptedly, and only in a few cases altered in strength. The rain water was used with one plant only, whose deportment was taken as a standard by which the effects of the acids were gauged, and it was used continuously with this one alone, an occasional application of water upon the rest supervening only after a very long treatment with acids. The acids employed were hydrochloric, nitric, sulphuric, formic, carbolic, tartaric, citric, tannic, and salicylic. The experiment began June 23, 1883, and lasted until September 6. The strength of acid solutions was 10 c. c. of acid, concentrated in case of the inorganic acids, and saturated cold solutions of the organic acids, in one liter of water. The solution of the salicylic acid was assisted by a slight addition of alcohol to water. The liquid volume used daily of these solutions for watering each plant was 115 c. c.

The organic acid solutions were strengthened on Aug. 1 to 40 c. c. of the saturated acid to one liter of water, with the exception of carbolic and formic, which were retained at their original strength, and the amount of both these latter, together with that of hydrochloric, nitric, and sulphuric acids, used to water the plants was reduced one-half. The behavior of these plants in detail was as follows, the plants being classed according to the *acid used:*

	June 25. Leaves.	July 13. Leaves.		Aug. 24 Leaves.
Hydrochloric.	6 full.	6 full;	stunted.	5 full.
Nitric	5 "	4 "	"	2 "
Carbolic	4 "	2 "	"	None.
Formic	4 "	6 "	"	5 "
Salicylic	6 "	7 "	growing.	4 "
Sulphuric	7 "	5 "	stunted	2 "
Tartaric	7 "	9 "	growing.	9 "
Tannic	6 "	9 "	"	9 "
Citric	5 "	7 "	"	7 "
Water	11 "	13 "	"	17 "

From the first day of the experiment the first six plants, with the exception of the salicylic, were unfavorably affected by the acids used, but maintained a deceptive appearance of vitality by curtailing their expenditure of force in growing and applying it upon a maintenance of leaves. The doses appeared severe, but none of them died excepting the carbolic-acid plant, which very soon became debilitated and indigent, and the nitric-acid plant, which died shortly after the experiment terminated. Of the rest the sulphuric-acid plant was the most thriving, then the hydrochloric-acid plant, and last, and just alive, the plant treated with formic acid. They were all stunted and depauperate in appearance. The remaining plants grew well, and, except in fertility of leaves, were not strikingly inferior in appearance to the water plant. The soils treated with inorganic acids first lost their retentiveness, and eventually all became similarly affected. The water plant alone formed a secondary radical branch.—*L. P. Gratacap, Amer. Naturalist.*

SALT WATER INSECTS USED AS FOOD.

Mr. Edwin A. Barber, of Philadelphia, recently sent us some Diptera, which he received from Professor A. Penafiel that were taken from the Lake Tetscoco in Mexico. They are a species of Ephydra which Dr. Williston, to whom we referred the fragments, believes is *E. hians* Say, described from Mexico. Dr. Packard (*American Journal of Science and Arts*, February, 1871, p. 103-5) describes two species of this genus, viz., *E. californica* from Clear Lake and Mono Lake, California, and *E. gracilis* from Great Salt Lake, Utah.

The insects of this genus are interesting not only by virtue of their inhabiting alkaline and saline waters, but also because the larvæ occur in such prodigious numbers, and form an extensive article of diet among the Indians of the West and Southwest. Professor W. H. Brewer, while working on the geological survey of California, found that the Indians gather from all around the vicinity of Lake Mono at specified seasons to collect the larvæ, which are washed up in windrows along the shores. From some interesting notes he has left with Dr. Williston it seems that this food is called koo-chah-bee. The worms are dried and sifted from the sand, the shell then rubbed off by hand, when a yellowish kernel remains like a small grain of rice, oily, nutritious, and not unpleasant to taste. Pulverized and made into cakes the food reminded Professor Brewer of the patent meat biscuit that was used during the war more than of anything else he could liken it to. There are no fish or reptiles in the lake, but countless millions of these Ephydra flies rest on the water and on everything round about it. It is probable that the insect is most washed up by the waves when assuming the puparium state near the surface, and that the yellow kernel referred to is the true pupa that dries within the puparium.—*Amer. Naturalist.*

THE CRAYFISH.

In his "Economic Relations of Wisconsin Birds," Mr. F. H. King remarks that crayfish have been so little studied in regard to their habits that an economic position cannot be satisfactorily assigned them at present. He then quotes as follows from a letter from Professor W. F. Bundy: "Crayfish feed on worms, small mollusks, insects that fall in their way, small fish, and in general any kind of animal food, especially carrion. They are industrious scavengers. This latter item, with the additional ones that they form a not inconsiderable part of food for fish, and their damage to meadows by burrowing, indicate where they come in the most direct relation to human interests." The river species, adds Mr. King, he regards as beneficial. Those which burrow in the meadows, building mud chimneys which become sun baked and interfere quite seriously with mowing, he is in doubt in regard to, but inclines to the opinion that their services as scavengers more than offset the damage they do. Crayfish are preyed upon to a considerable extent by various species of herons and some other birds.

THE BOTTLE NOSE WHALE.

There has been considerable confusion respecting the species of genus *Hyperodon*, since Dr. Gray described and figured *H. latifrons* from a skull found at the Orkney Islands. The characters upon which Dr. Gray's species afterward made into a genus entitled Lagenocetus, was founded certainly seemed important enough to be specific, since the ascending part of the maxillary, which in skulls referred to *H. rostratus* were thin, were in the type of *H. latifrons* very thick, nearly touching each other in front of the blower, and higher than the hinder part of the skull. Nevertheless Professor Eschricht expressed his opinion that *H. latifrons* was only an old male of the ordinary *rostratus, bidens, butzkopf*, etc. (as it had been variously called). Dr. Gray, in rejoinder, asserted that the fisherman who procured the head had assured him that it was that of a female gravid with young. Thus the matter rested until last year, when the second species was definitely disposed of by the observations of Captain Gray, before whom the subject was brought by Professor Flower.

Captain Gray, observing the frequency of this Ziphioid in the seas between Iceland and Spitzbergen, harpooned several and brought back their oil. This, upon analysis, proved to so closely resemble that of the sperm whale as to be probably of equal value for the special purposes for which sperm oil is used. This, with the discovery that spermaceti existed in the head, induced Captain Gray to devote himself to the capture of bottle noses.

A series of skulls and of skeletons brought back by this gentleman showed the gradual increase of the maxillary elevations in the male, until in old individuals the head takes on a quadrangular box-like form, squarely truncate in front, but differing from that of the sperm whale in the presence of a small beak below it.

According to Captain Gray's notes, this toothed whale attains a length of thirty feet, and then yields two tons of oil and two hundredweight of spermaceti. It feeds upon small cuttlefish, and in pursuit of them stays below longer than others of its order, a fact which makes it difficult to kill. After running out 700 fathoms of line, and remaining below two hours, an old male will come up so fresh as to require a second harpoon, and will attack the boats with head and tail. So strong are the muscles of this whale that it can not only leap clear out of water, but can guide itself in descending so as to plunge head first, instead of falling helplessly sidewise like the larger whales.

A SQUEALING TOAD.

On the 24th of May, an unusually warm day for this region, while walking on the University grounds at Berkeley, I noticed something hopping along on the hot gravel of the road; upon close inspection it proved to be a toad. It was heading for a small bunch of weeds for shelter; as it squealed like a mouse when I first poked it, I repeated the poking several times, taking care not to hurt it; with each poke it squealed as at first; if my eyes had been shut, I should have supposed the squealing to have been made by a mouse. After experimenting for a few minutes, I finally placed it in the shelter of the weeds and walked on.

Though not a specialist as regards toads, I have had the honor of an acquaintance with these animals for many years, but this squealer is the first I have met with.—*R. E. C. Stearns, in Cultivator's Guide.*

THE SPURS AND CLAWS OF BIRDS' WINGS.

In a recent issue of the Proceedings of the Boston Society of Natural History, J. A. Jeffries has an interesting article on the claws and spurs of birds' wings. A spur consists of a bony core on the anterior side of the arm, surrounded with connective tissue and covered with a thick horny coat, while a claw upon a wing is the homologue of that upon a foot, that is, it is a horny case surrounding an ungual phalanx. The spur occurs in birds so widely separated that it cannot have been inherited from a common ancestor. Claws are a far more common occurrence, but are inconspicuous, and useless as weapons, but are of value in classification. They are on the end of the first finger of many birds, and much more rarely on that of the second. A first finger with two phalanges almost or quite always bears a claw on the last, but a second finger with three phalanges may be clawless. Accordingly the ancestors of birds had a two-jointed first finger, and a three jointed second finger, and agrees so far with that of reptiles and mammals. A list of the phalanges of the hand, and spurs and claws found in different groups of birds is given, and it is pointed out that the number of phalanges is least, and the claws are absent, in what are usually considered the highest groups of birds. The writer points out that it is unadvisable to put birds with a complete phalangeal schedule as descendants of those with an imperfect one, as has sometimes been done.

ELECTRIC FISH.

At a recent meeting of the Berlin Physiological Society, Du Bois Reymond communicated a short notice from a letter of Professor Babuchin to him which contains a fact interesting as showing the power of adaptation to their surroundings that electric fish possess. Professor Du Bois Reymond had previously called attention to the fact that the electric eels and Malapterurus that live in badly-conducting fresh water show, in as far as they have accommodated themselves to this medium, a considerable development of their electric organ in length compared with the small size of its transverse diameter; whereas in the electric rays that live in sea water, which is a good conductor, the electric organ has a greater transverse development, consequently the electromotor powers of the electric organs of the electric eel and Malapterurus on the one side, and of the electric ray on the other, were to one another inversely as the conductibility of the surrounding media. The measurements of Humboldt and of Sachs of growing electric eels had shown that in their growth the electric organ increased proportionally more in length than in transverse diameter, which is a teleological adaptation to the badly-conducting fresh water. Now the above mentioned note of Professor Babuchin contained the communication that in growing electric rays the electric organ increased proportionately much more in breadth than in height; this is likewise in conformity with the adaptation to the sea water, which is a good conductor.

AN ELEPHANT'S REVENGE.

One of those pests of society, "a practical joker," visited a caravan in a West of England fair, and tried his stupid tricks upon an elephant there. He first doled out to it, one by one, some gingerbread nuts; and when the grateful animal was thrown off its guard, he suddenly proffered it a large parcel wrapped in paper. The unsuspicious creature accepted and swallowed the lump, but immediately began to exhibit signs of intense suffering, and snatching up a bucket handed it to the keeper for water. This being given to it, it eagerly swallowed quantities of the fluid. "Ha!" cried the delighted joker, "I guess those nuts were a trifle hot, old fellow." "You had better be off," exclaimed the keeper, "unless you wish the bucket at your head." The fool took the hint only just in time, for the enraged animal, having finished the sixth bucketful, hurled the bucket after its tormentor with such force that, had he lingered a moment longer, his life might have been forfeited. The affair was not, however, yet concluded. The following year the show revisited the same town; and the foolish joker, like men of his genus, unable to profit by experience, thought to repeat his stupid trick on the elephant. He took two lots of nuts into the show with him, sweet nuts in one pocket and hot in the other. The elephant had not forgotten the jest played upon him, and therefore accepted the cakes very cautiously. At last the joker proffered a hot one; but, no sooner had the creature discovered its pungency, than it seized hold of its persecutor by the coat-tails, hoisted him up by them, and held him until they gave way, when he fell to the ground. The elephant now inspected the severed coat-tails, which, after he had discovered and eaten all the sweet nuts, he tore to rags, and flung after their discomfited owner.—*Chamber's Journal.*

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